The **HOW AND WHY** *Wonder Book of*

45p

RADIO and TV

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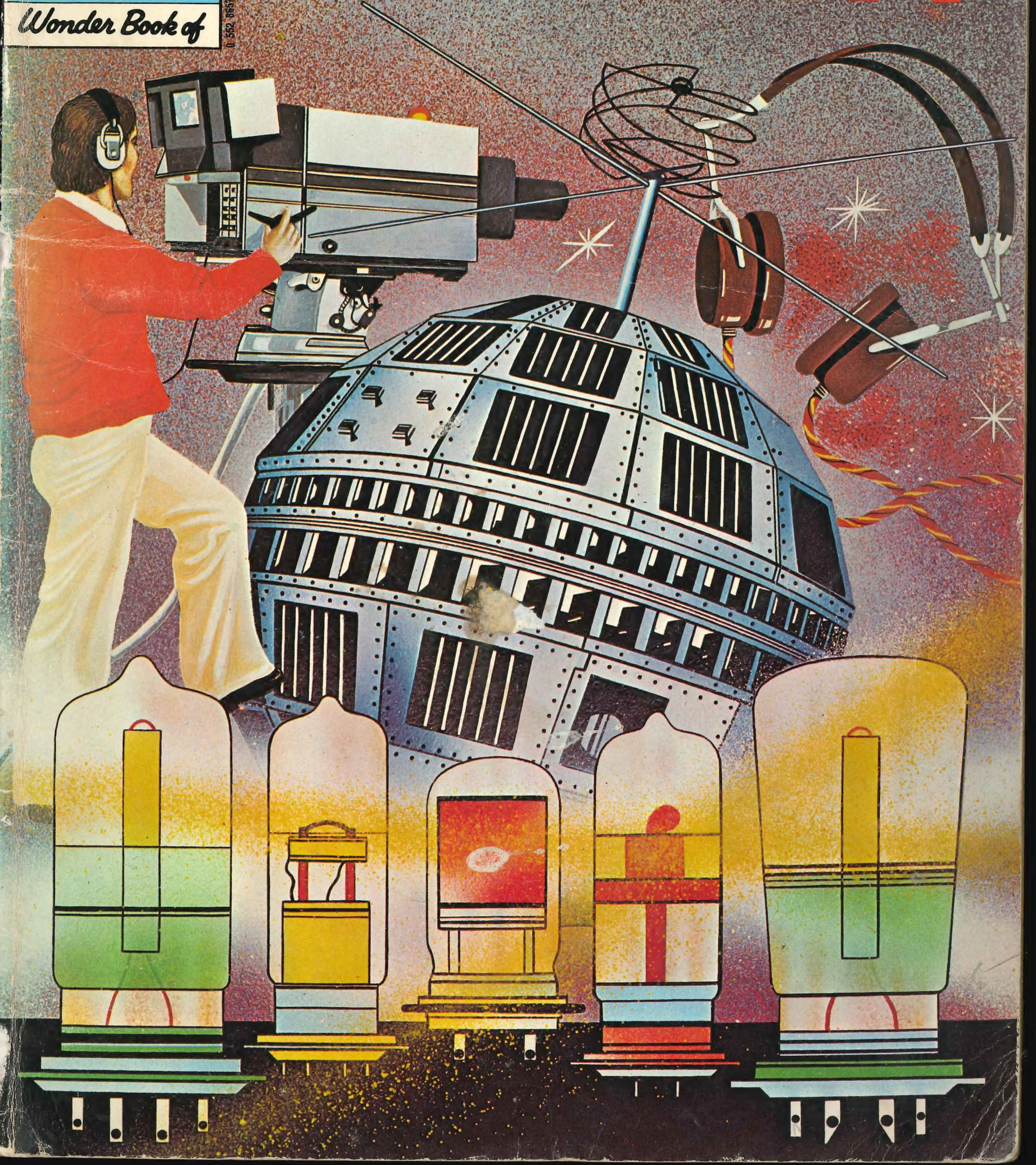

Nigel Hellier

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THE HOW AND WHY WONDER BOOK OF

RADIO AND TV

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Illustrated by RAYMOND TURVEY

TRANSWORLD PUBLISHERS · LONDON

Introduction

This *How and Why Wonder Book* deals with the rapidly growing world of radio and television – a world that is little more than fifty years old, yet in its brief lifetime has affected the lives of millions of people perhaps more than any other of man's inventions – except the wheel.

The book outlines the importance of looking and listening in everyday life and shows how they depend upon sound and light waves – waves that are very similar to radio waves. It presents a short history of radio and television and outlines the major techniques involved in their use. This is followed by a survey of how radio and television productions get 'on the air' (from first idea to final transmission) and a behind-the-scenes picture of both production and administration departments at work. The book also describes Closed Circuit Television and takes a look at possible future developments.

There is no need for the non-technically minded reader to be worried about being confused or blinded by the scientific aspects of radio and television. Although the subject is technical, the text is free from jargon, and all the important or tricky technical points are covered by the many easily understood illustrations which are a feature of the book.

The *How and Why Wonder Book of Radio & Television* shows something of the great leap man has taken in communications since Heinrich Hertz first experimented with radio waves in his laboratory. We are now able to probe the moon and beyond with microphones and television cameras – those modern pieces of machinery that deserve to rank with the old Seven Wonders of the World. Today they are our eyes and ears.

The book should be of help to children, students, teachers and parents in providing an up-to-date guide to two of man's most fascinating and powerful technological aids: radio and television.

Originally published in Great Britain by Transworld Publishers Ltd.

PRINTING HISTORY

Transworld Edition Published 1976

The How and Why Wonder Book Series is originated and published in the U.S.A. by Grosset and Dunlap Inc.
Published by Transworld Publishers Ltd., Century House, 61/63 Uxbridge Road, Ealing, London W5 5SA.
Printed by Purnell & Sons Ltd., Paulton (Avon) and London.

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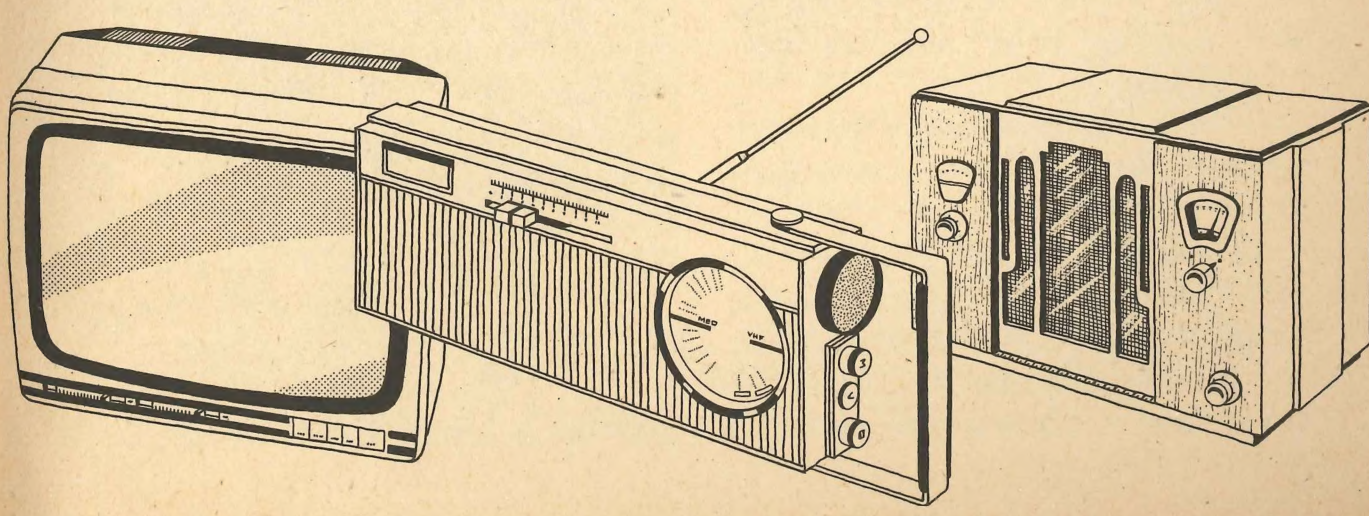
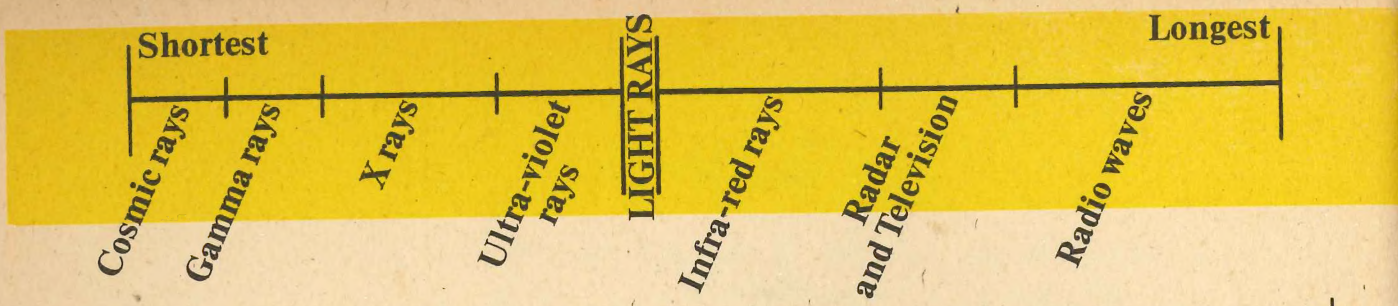
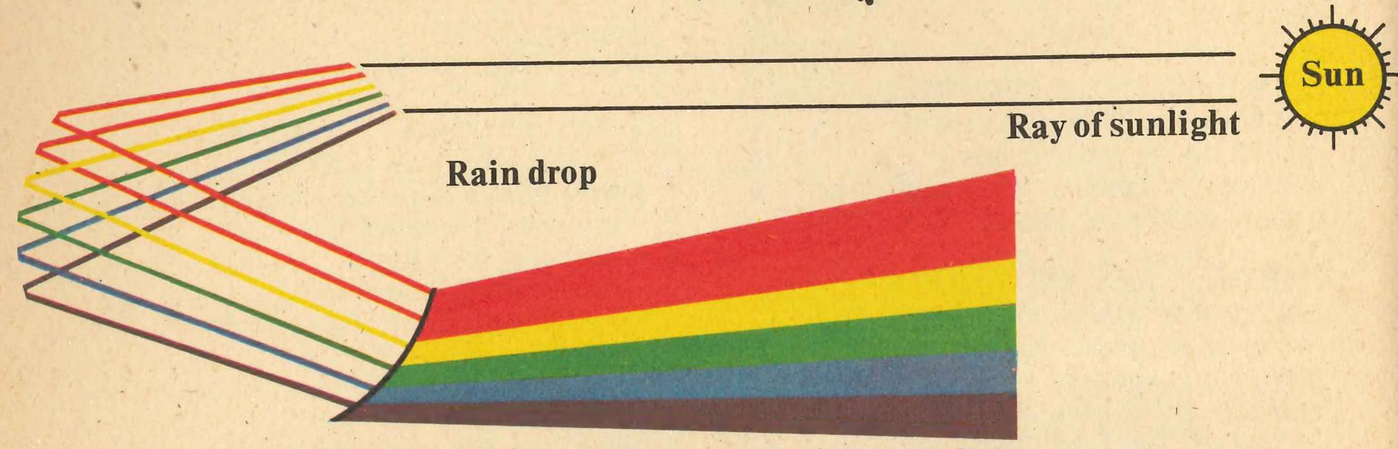






The electro-magnetic spectrum.

The spectrum of the rainbow

Viewing and Listening

What does *Television* mean?

Television and radio are two of the most powerful weapons used by today's mass media. They are modern and complicated. They use light rays and sound waves so that we can *see* and *hear* what they put out; what they *broadcast*: the messages they send through the air and space.

Broadcasting is the word we use generally for all or part of the complicated processes and business of sending and receiving radio and television programmes.

The word *broadcast* means to scatter and disperse widely and without constraint over a general area. The word *radio* comes from the Latin word *radius* meaning a spoke or a ray: a straight line travelling between a point and the circumference of a circle, or the surface of a sphere, of which the point is the centre. A French word for radio is *tsf* (tee-ess-eff) standing for *telephonie sans fil*: telephone without wires. Our own, now old-fashioned, word wireless speaks for itself. The word *television* is a little more difficult. The Greek word *tele* means from a great distance, and the Latin word *visio* comes from the verb 'to see'.

All radio and television broadcasting systems are based upon the way people see and hear. We can see only because our eyes are sensitive to one form of electro-magnetic energy: *light rays*. We are able to hear only because our ears are sensitive to vibrations in the air: *sound waves*.

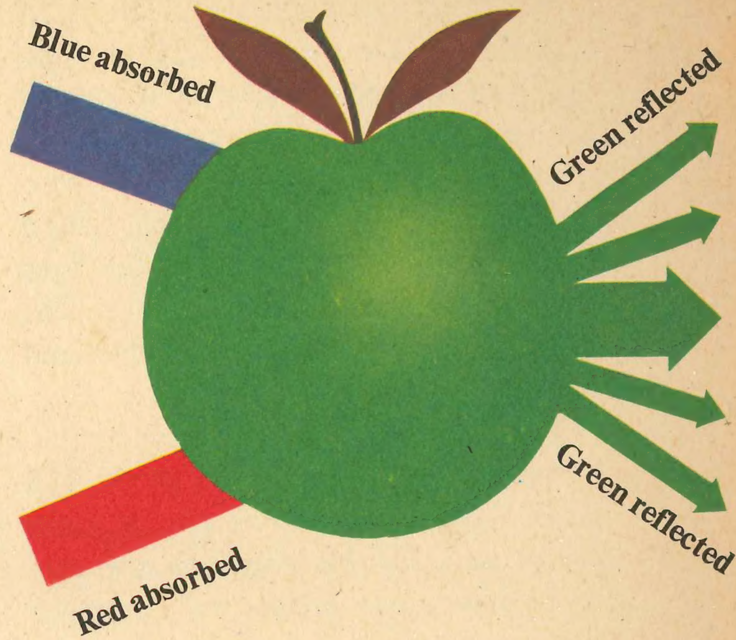
How do we see and hear?

We live in a world of light. Light that comes naturally from the sun and artificially from such things as matches and street lights.

Light rays surround us everywhere but we cannot see them, although we see by them and can often see their source.

If you place your hand between this page and your eye you will interrupt the light rays and no longer see the page. Your hand is not sensitive to light rays, as your eye is, and you cannot 'see' with it. It is not transparent, as glass is, and you cannot see through it. Instead, you 'see' your hand and not the page.

Light rays are radiated in virtually straight lines from a source and travel at a tremendous speed (nearly 200,000 miles per second – or round the earth in less than $\frac{1}{10}$th of a second). They travel in wave formation and can span a vacuum such as space.



A green apple *absorbs* the red and blue light in white light and *reflects* only the green light. That is why it looks green.

Rainbows are formed when the sun shines through raindrops.

The human eye cannot discern all light rays. Generally speaking, we are able to 'see' only those rays that come from a source radiating electro-magnetic energy with wave-lengths between 4,000Å and 7,000Å. (Å = $\frac{1}{10}$ millionth of a millimetre.)

Sound waves are radiated in virtually straight lines from a source and travel at a speed of just over 700 miles per hour. Sound waves cannot span a vacuum but need a carrier vehicle such as air or water. A sound source vibrates and its message or signal is almost always carried to our ears by vibrations in the air.

The human ear cannot discern all sound waves. Generally speaking, we are able to 'hear' only those waves that come from a source vibrating with a frequency between 25 'beats' per second and 20,000 per second.

We 'see' when light rays from an object enter the eye through the *pupil* and pass through the *lens* to be focused on the *retina* – a miniature viewing screen at the back of the eye. The optic nerve which is attached to the retina passes on the impulses from the light rays to the brain for interpretation. The brain 'makes sense' of the impulses and we 'see' *images*.

We 'hear' when vibrations in the air (sound waves) strike the eardrum. The *outer ear* acts as a horn to catch the waves and funnels them to the eardrum where the *middle ear* organises (or transforms) them so that the *inner ear* can pass them on to the brain as electrical energy patterns. When the brain 'makes sense' of these patterns we 'hear' sounds.

The three major parts of the eye and the ear have similar functions. The pupil and the outer ear catch the stimuli (light rays and sound waves); the lens and the middle ear organise them; and the retina and the inner ear pass their signals on to the brain.

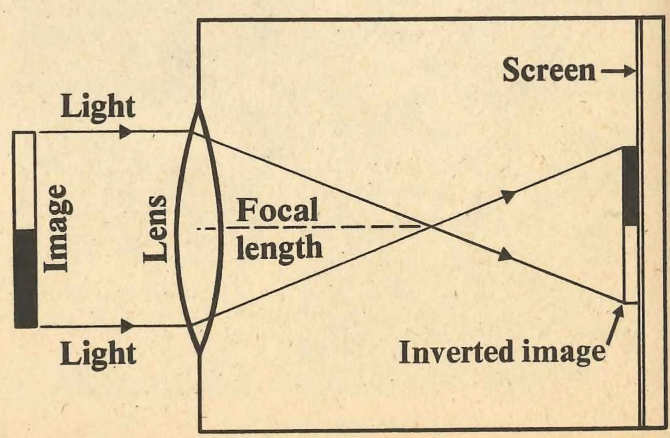
What are lenses and microphones?

The camera is television's eye; the microphone a listening ear for television and radio alike. There are many similarities between them and their human counterparts.

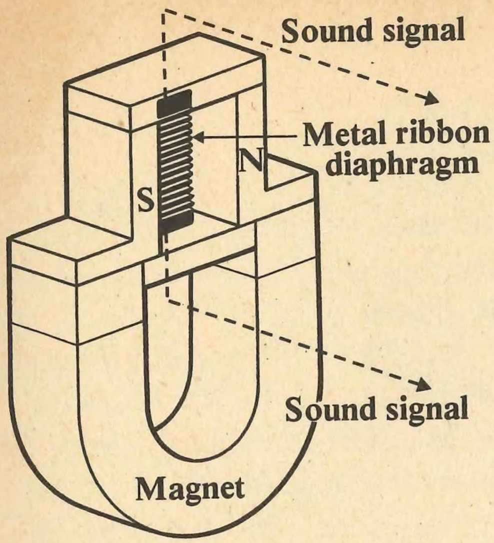
The human eye and the television camera both need light rays in order to work; an opening to admit the light rays (pupil in the eye – aperture in the camera); a lens to organise the light rays (gristle in the eye – glass in the camera); and a screen to take the image (retina in the eye – photo-electric cells in the camera). While all these are essential, perhaps the *lens* takes pride of place.

Lenses *bend* light rays to form an image that makes sense to us, and without them we should see only a foggy blur. In the television camera, lenses bend light rays into a focused image that can be changed into electronic impulses. Some lenses bend light rays sharply and they are said to have a short *focal length*. The focal length of a lens indicates the rate at which it bends light. This is of great importance to the television cameraman when he is making up his mind what kind of shot he wants to take.

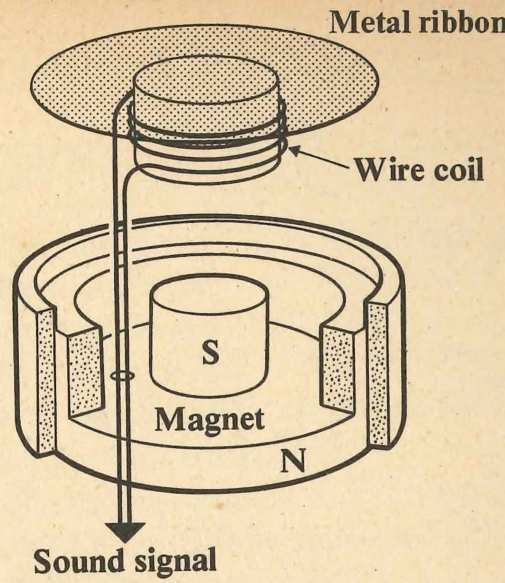
Our two eyes enable us to see stereoscopically, or in 3D. That is, each eye sees a slightly different image because of its different position in space (its *placement*) and this helps us to judge distance. (You can see how this works by holding your finger at arm's length and lining it up with an object 3 feet away. If you hold your finger still and close first the right eye and then the left, your finger will *appear* to move across the object. If you repeat the experiment with objects at 3 yards, 10 yards and even further, you will see



A simple converging lens.



A ribbon microphone.



A moving coil microphone.

how your finger *appears* to travel even further as the distance increases.) We are not yet able to broadcast 3D television pictures domestically.

Microphones catch sound waves just like the human ear. The waves strike a *diaphragm* causing it to vibrate and so pass on its signal. This signal is converted into electric impulses and later changed back into sounds very close to the original.

Our two ears enable us to hear stereophonically. That is, each ear picks up a slightly different set of sounds because of its different placement. Television and radio create stereophonic sound by using two microphones to listen and two speakers to play back.

Eyes and ears, cameras and microphones all catch, organise and pass on in another form the signals they get from travelling *waves*. We shall look again at all this later in the book.

How do we see colour?

When we talk of light we generally mean white light or that nearly white light that comes naturally from the sun or artificially from gas and electricity.

All colour comes from white light. Any beam of ordinary white light, no matter how thin, is a bundle of rays of different colours. The most obvious are red, orange, yellow, green, blue and violet. Any beam of ordinary light can be spread out like a fan so that the colours appear separately in what is called a *spectrum* (a Latin word meaning 'appearance'). This happens when light passes through glass or water. One effect is the well-known spectacle of the rainbow.

The human eye and the television camera respond only to the three primary colours of light: red, blue and green. Every colour is made and sensed from these three, and all colour television pictures come from just these three primaries.

Coloured objects appear coloured because they reflect only light rays of a certain wave-length: their colour. A green apple looks green because it absorbs all the colours but green. It reflects only green light. We see only green light and the apple looks green.

Colour television is a far cry from the first historic sparks of sound radio It is a fascinating story.

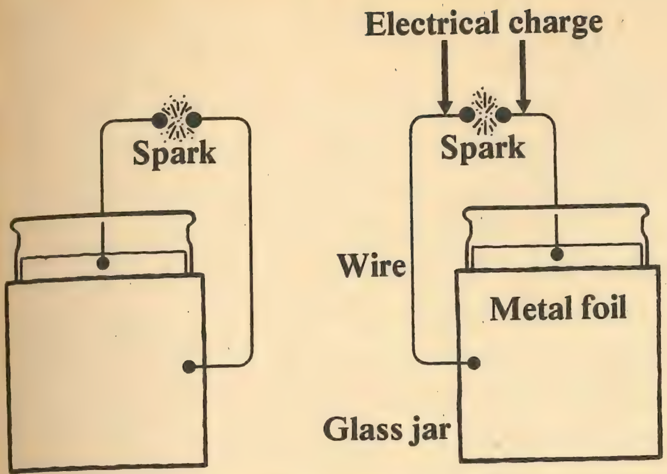
The History of Radio

What were the greatest landmarks in tele-communication?

Although radio waves have probably existed for much longer than the earth on which we live, we have known about them for only just over a century. The first tiny but significant discovery was made by Heinrich Hertz in 1880 when, with very simple apparatus, he managed to transmit basic radio waves a few feet across his laboratory. The second major step was achieved by Marconi and his colleagues in 1901 when they transmitted the Morse signal for the letter *S* 2,170 miles across the Atlantic from Poldhu, Cornwall, England to St. John's, Newfoundland, Canada. The next steps were really leaps. In 1962, Telstar, the first active communication satellite was established in space. Measuring less than a metre in diameter, it contained more than 15,000 electronic parts powered by 3,600 solar cells. In 1969, Apollo 11, landed on the Sea of Tranquillity on the Moon. Since then we have transmitted radio messages over millions of miles and received them from the very edge of the observable universe, some 15,000 million light-years distant (one light-year = the distance travelled by light, at nearly 200,000 miles per second, in one tropical year).

Who first thought of radio?

The whole idea of radio waves, involving their speeds, distances and their invisibility, is such a fantastic proposition that it is hardly surprising that the man who first thought of it was laughed at. This is precisely what happened to James Clerk Maxwell a pupil of Michael Faraday, Fellow of the Royal Society. In 1864 Maxwell completed a piece of work in mathematics in which he outlined many of the laws and principles governing those space energies or forces that we now call *radio waves*. Without the benefit of any practical experiment, he proved that they travelled in the same way as light waves, that they could be bent, focused, absorbed and reflected. He estimated their speed accurately. Most important, he stated it was possible for man to produce and control these radio waves. Although a man called Edward Hughes made his own radio receiver and actually heard radio waves in the centre of London in 1879, neither Maxwell nor Hughes was believed. Even the supposedly open-minded scientific research body, the Royal Society, would not accept the possibility that Maxwell's claims were true. (It is appropriate to note here that the 1974 edition of the *Guinness Book of Records* states the following: "The earliest description of a radio transmission system was written by Dr. Mahlon Loomis (U.S.A.) (b. Fulton County, N.Y., 21 July, 1826) on 21 July, 1864 and demonstrated between two kites more than 14 miles (22 km) apart at Bear's Den, Loudoun County, Virginia in October 1866. He received U.S. patent No. 129,971 entitled *Improvement in Telegraphing* on 20 July, 1872. He died in 1886.)



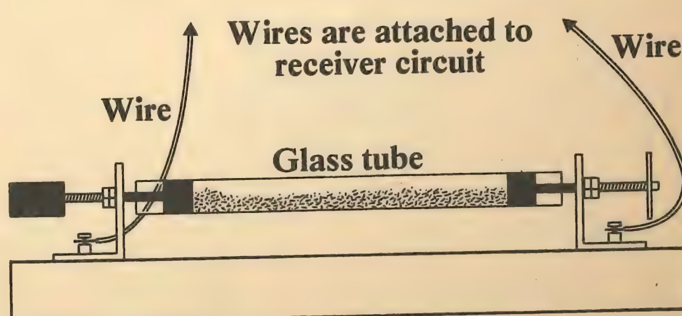
Hertz's Leyden jars. With these, Hertz first discovered radio waves.

Who proved Maxwell right?

It was not until 1888 that a German professor, Heinrich Hertz, carried out practical experiments that proved Maxwell's ideas to be correct. Hertz used very simple equipment: two glass jars coated with metal foil inside and outside. They are known as *Leyden jars* after their inventor. They are in fact *condensers* and store up an electrical charge. Hertz fitted each of his jars with a circle of wire and left a small gap, across which any electric charge would jump with a noticeable spark. (These wires were the first crude *aerials*.) He placed one jar on one side of his laboratory and the second jar on the opposite side. He then electrically charged one jar so that a spark jumped across the gap in the wire. Almost instantaneously a spark jumped across the gap on the other jar. History had been made: radio waves had crossed the room and given the second jar an electrical charge. Because of Hertz's experiment, these waves were known for a long time as *Hertzian waves*. Professor Maxwell had been proved right.

When sparks jump across a gap they will create nothing but a click in headphones or loudspeakers. (You can hear this for yourself when a light or power switch is used near a radio.) Further experiments had to be made before radio waves could be used to send actual messages. This occurred in 1894 when Oliver Lodge improved a *coherer* first used by Edouard Branly, a French professor of physics. The coherer was a small glass tube filled loosely with iron filings. Normally, loosely packed iron filings will not readily pass an electric current, but when a wire with radio waves flowing in it is connected to them in the tube, they cohere, or stick together. When they are more closely packed together (cohered) they allow a current to pass through them more easily. Lodge used this feature to create a radio receiver that rang a bell every time his miniature connected aerial received a radio signal. He improved the equipment so that the cohered iron filings were automatically dislodged (de-cohered) after each signal had been received. By using a Morse key at the transmitter and a buzzer/bell at the receiver it was possible for the first time to send readable messages.

A simple coherer. In 1894, Oliver Lodge used similar equipment to send the first readable message.



The important key to the development of long-distance radio transmission was the exploitation of the aerial. In 1896 William Preece, Chief Engineer to the G. P. O., arranged for all the telegraph lines in England to be connected together. He made a similar arrangement in Ireland. He hoped that the electric currents in the wires in one country might *induce* similar currents in the wires in the other. Although the experiment did not succeed, it drew widespread attention to the effect of *induction*.

How did the Post Office help?

Much earlier, Preece had noticed some unexpected signals in overhead telegraph cables and had discovered they were caused by currents flowing in nearby underground cables, although the two sets were more than eighty feet apart vertically. The unexplained signals were caused by induction.

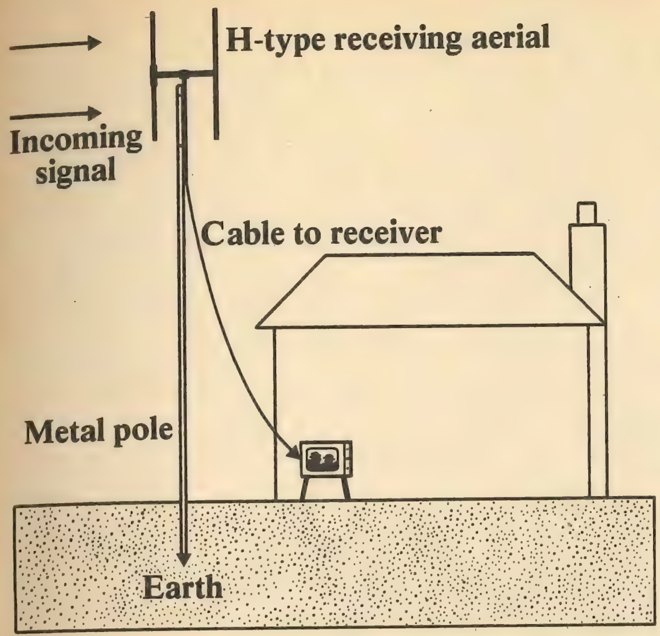
Induction occurs when the *magnetic field of force* surrounding a wire through which electric current is flowing, influences a second wire so that it too carries a similar electric current to the first. William Preece thought that if this occurred accidentally between overhead and underground cables it could be brought about much more effectively between two sets of specially arranged wires.

Although Preece's hopes of transmitting signals over many miles by this method were not fulfilled, they did make him the obvious person for the great experimenter Marconi to contact.

How did Marconi amaze the world?

In 1896, the Marchese Guglielmo Marconi met William Preece and demonstrated his system first on the roof of the General Post Office and later on Salisbury Plain. Important officials from government, army, navy and the Post Office were present on both occasions and very impressed by Marconi's equipment and its ability to transmit radio signals over a distance of one and a half miles.

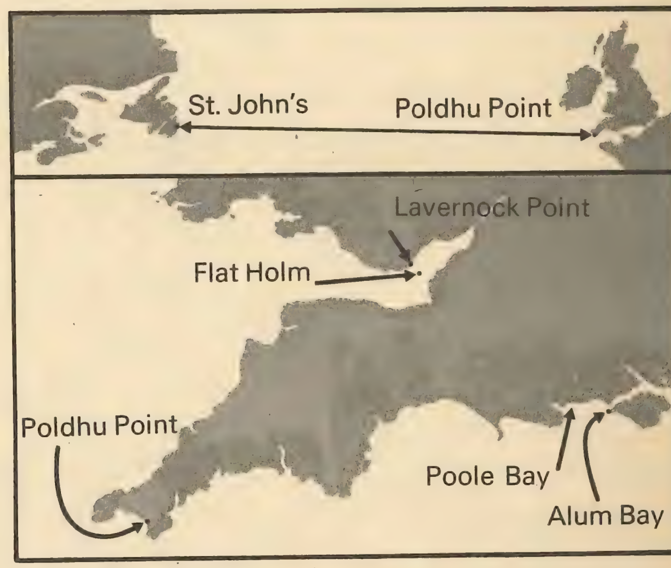
An early Marconi transmitter. Marconi's success in transmitting radio signals over a distance of one and a half miles was due to his improving the apparatus used by earlier experimenters and discovering the aerial-to-earth system.



The aerial-to-earth system. Marconi discovered that by raising one arm of the aerial high in the air and burying the other in the ground, he could transmit for miles instead of yards.

Marconi claimed that his success came from improving the apparatus used by earlier experimenters (coherer, de-coherer, induction coil, etc.) and discovering the *aerial-to-earth* system. He had found that the longer he made the arms of his aerial, the further he could transmit radio signals. By further experiment he had discovered that if he raised one arm of the aerial high into the air and buried the other arm in the ground (*earthed* it) he could transmit for miles instead of yards.

Preece arranged for the Post Office to back Marconi's experiments. In 1897 Marconi made successful transmissions from Lavernock Point on the coast of Glamorganshire to Flat Holm Island, a distance of eight miles. In 1898 Marconi transmitted from specially set up stations at Alum Bay, Isle of Wight and Poole Bay nearby. (Poole Bay continued to operate until 1926.) The signals were received by ships also fitted with special equipment, and the transmissions covered a distance of eighteen miles. It was during this time that Marconi discovered that radio communication was easier over water than land. Shortly after he discovered that it was easier at night than during the day.



Marconi's transmitting and receiving stations.

In the following year, 1899, the British and United States Navies began fitting Marconi system radios in their ships, and as a result, were able to keep in touch over a distance of nearly one hundred miles. In the same year the English Channel was spanned by radio and the East Goodwin Lightship was able to radio for help when it was rammed by the freighter *R. F. Matthews*. By 1901, Marconi had improved his system sufficiently to be able to transmit from Poldhu to St. John's, using an aerial taken to a great height first by a balloon and then by a box kite.

From Hertz's first experiments to man's achievements in space: from small steps to fantastic leaps.

When Marconi demonstrated his radio equipment on Salisbury Plain, many important people came to watch.

It was during this time that Marconi had the benefit of the technical advice given by Ambrose Fleming. This was fortunate since although radio transmissions of Morse Code could be effectively made across the world, they were suitable only for the passing on of messages, not general broadcasting. The time was ripe for another important step.

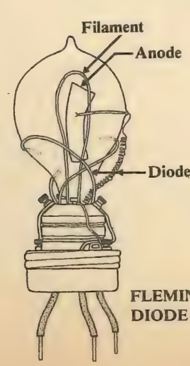
Who invented radio valves?

In 1875, Alexander Graham Bell had invented a telephone system that worked well through land lines carrying speech and music, not just Morse Code. David Edward Hughes had invented a microphone suitable for radio use, but the systems had not been put together and voices could still not get 'on the air'.

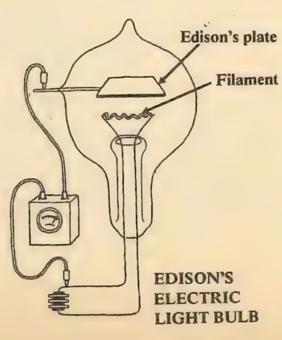
In 1904, Ambrose Fleming had been working on some peculiarities in electric light bulbs that Thomas Edison had first noticed. Fleming's experiments led him to create the first radio valve which looked remarkably like a spoiled electric light bulb.

Fleming's valve affected the radio currents (which before merely produced a click in the headphones) so that they made signals which were recognisable to the human ear as the sounds of everyday life as they were transmitted, especially those of speech and music.

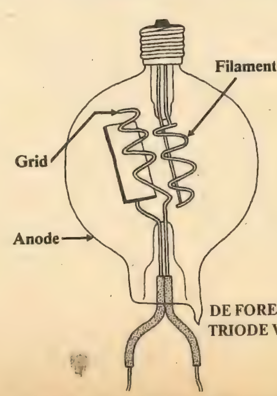
Fleming's valve consisted of an electric lamp with two elements: a filament (the first *electrode*) and a plate (the second electrode, or *anode* as we call it today). The two elements gave it its name: a *diode* or thing with *two*



FLEMING'S DIODE VALVE



EDISON'S ELECTRIC LIGHT BULB



DE FOREST'S TRIODE VALVE

ways. The plate was a thin piece of flat metal firmly fixed inside the glass bulb. When the filament became heated as a result of an electric current being passed through it, it poured out streams of electrons (*negative* electric charges) at very high speeds. If the plate were *positively* charged the electrons would 'fly' straight to it. Fleming used this effect in his valve to detect and control radio waves. The only drawback was that the signals were weak and at a low level. If they were to be used in general broadcasting, a way had to be found of strengthening (*amplifying*) them.

This amplification was achieved through the invention of the *triode*: the three electrode valve. In 1907, Lee De Forest, an American, added to the diode a spiral of fine wire, called a *grid*, that was firmly fixed between the filament and the plate. The intervention of the grid in the flow of electrons gave much greater control. Radio waves could be detected more easily and amplified at will. The triode was found also to be capable of *oscillating* (vibrating in alternating frequency) thereby helping to create even more radio waves. It could also be used for transmission.

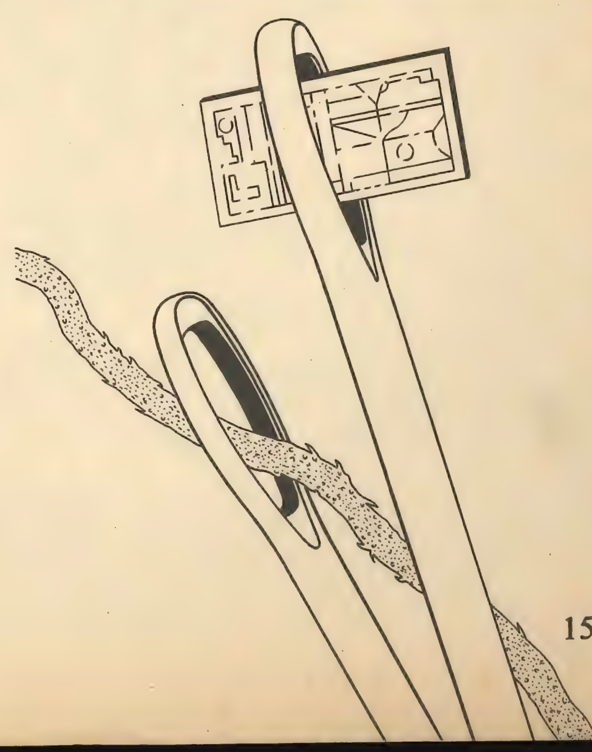
Many years later, valves containing many elements were used. In the end they became like Chinese boxes: valves within valves within valves. They tended to be comparatively cumbersome and were certainly fragile and it was not for many years that an important change came about.

Why do we use transistors?

In 1948, three Americans (Bardeen, Brattain and Shockley) working for the Bell Telephone Company, invented what we now commonly refer to as *transistors*. The results of their work are now all round us in radios, record players, tape-recorders, television sets, etc. Space exploration, for example, would hardly have been possible without them since they are so light, small and compact.

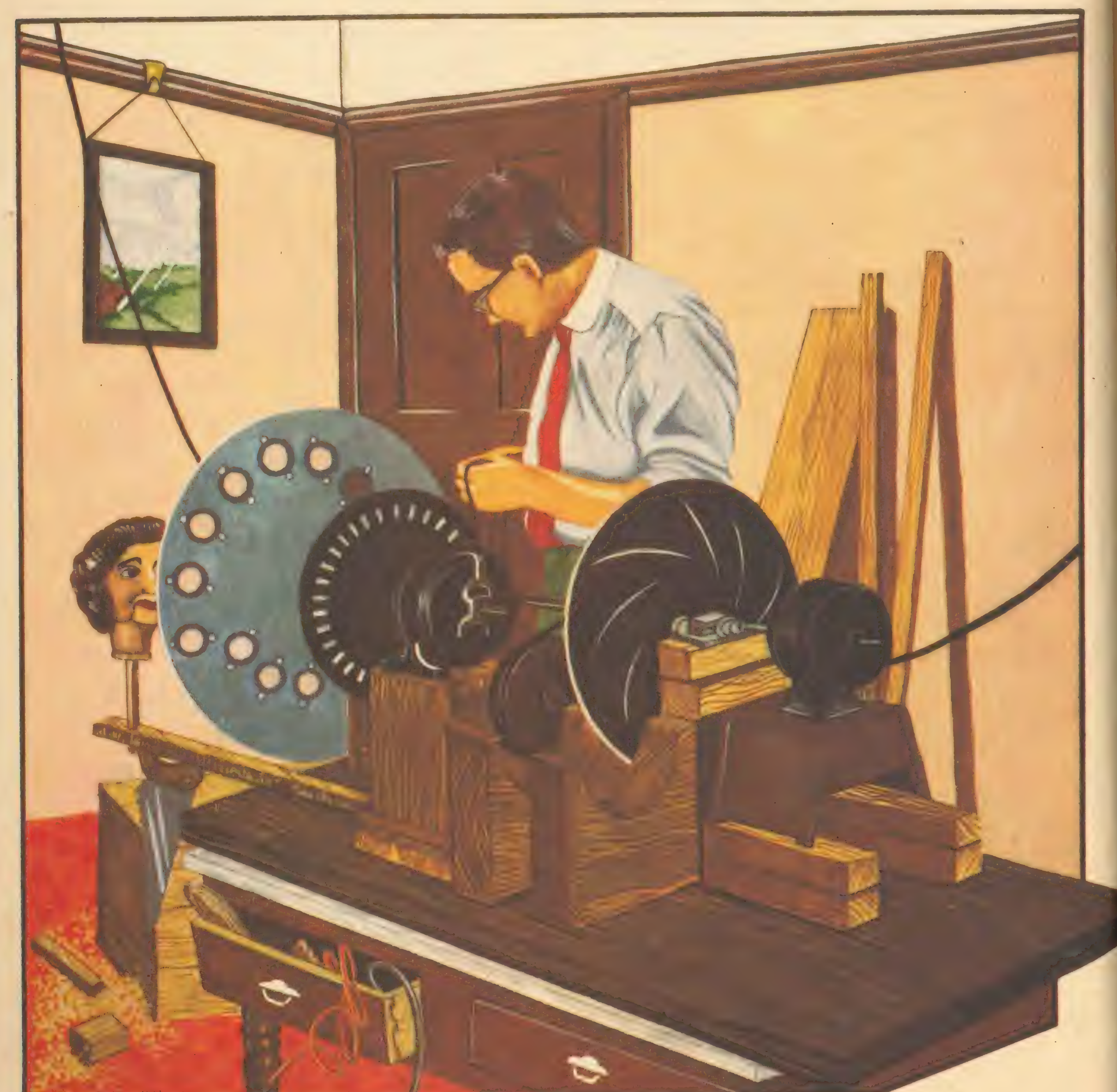
Like valves, transistors have three electrodes and work in a broadly similar way. Their special merit lies in the facts that they are very small and, having no filament to heat up, work immediately. They use little current and operate from small batteries of low voltage which are also long-lasting like the transistors themselves – different from both valves and their associated batteries. In fact, transistors can be made so small that they can actually pass through the proverbial eye of a needle.

A transistor compared with a needle and thread for size.

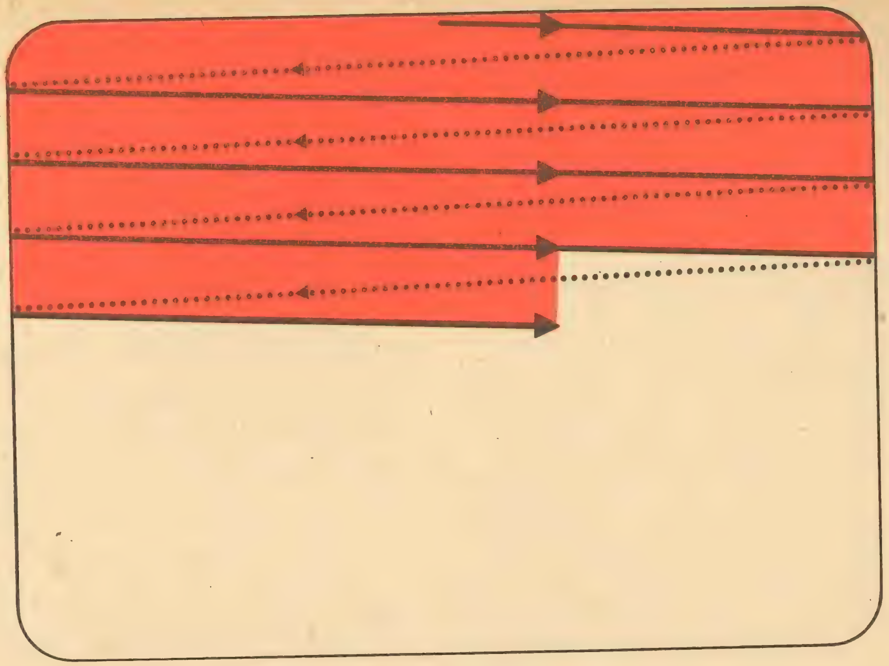


Only one hundred years have passed since the story of radio began. What started with a radio wave crossing a small room and setting off a spark has grown into a world-wide scientific and commercial operation, blanketing the earth and probing the very edges of the universe. Even now the present stage promises only to be the beginning.

The Story of Television



Baird experimenting with his scanners and his ventriloquist's dummy.



A diagram of the left to right movement known as scanning.

Radios and telephones work by sounds being converted into electric impulses, conveyed to their destinations (telephone handsets or radio loudspeakers) as such, and then changed back into sounds again. The device that enables this to be done is the *diaphragm*, both in the microphone and the speaker. The same principle of conversion and change back applies also to television, but with light not sound, and the device that enables it to be done is, of course, sensitive, not to sound, but to light.

What was Nipkow's Disc?

There is an important difference between how we sense sound and light. Our ears can take a general blending of sounds and easily organise them to make sense. Our eyes cannot do this. They need many tiny, exact details of a scene presented separately. Any picture transmission, on film or television, must work in this way.

A method of doing this was invented by a German engineer, Paul Nipkow, in 1884. His system consisted of an apparatus with a revolving disc into which had been cut a spiral of holes. As the disc revolved, each hole revealed a slightly different spiralling slice-line of the scene to be transmitted. The operation was called *scanning* which is a process very similar to the kind of eye movements you use to read the words on this page. In this way the contrasts of light and shade in a scene were transmitted to be decoded at the receiving end by the use of a similar disc. The snag was to find a sensitive device that would react to contrasts in light and shade and convert them into electric impulses.

Why was Selenium important?

What was needed at this stage was a television equivalent of the diaphragm. The first *photo-sensitive* (responsive to light) material to be used was *selenium*: a non-metallic element related to Sulphur.

It is a *semi-conductor*, which means that it conducts electricity better than an insulator but not so well as a metal conductor. Like all semi-conductors, selenium is sensitive to light and therefore suitable for use in photo-electric cells (elements that convert light into electric impulses). Moreover it varies its resistance to the flow of an electric current according to the intensity of light falling upon it.

Nipkow exposed his scanned images to a screen made of selenium and the first television transmission had been achieved. Selenium was consistently used over the years although it was not the perfect medium, because its response to light was too slow for the fast-moving scanning discs.

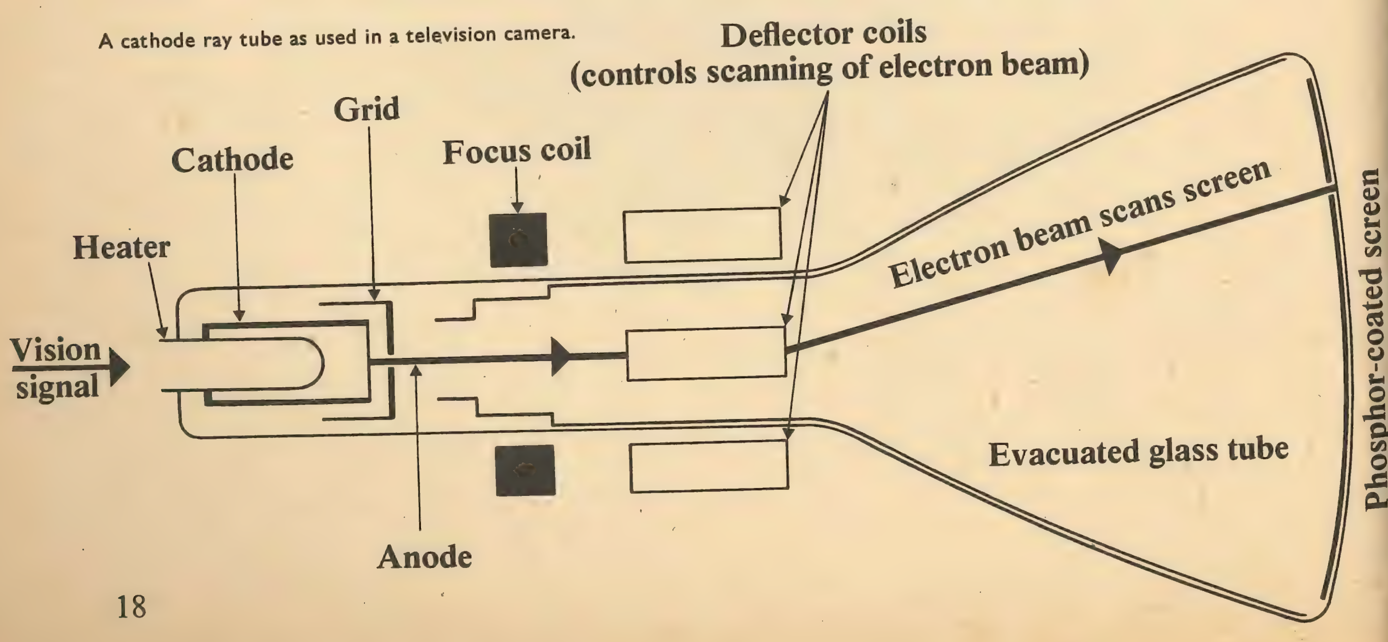
Who used a ventriloquist's dummy?

The first major variation from Nipkow's Discs was a revolving mirror drum invented by Weiller and the second was the use of a *Cathode Ray Tube* (CRT) at the receiving end.

Briefly, a CRT is an evacuated (to a near-vacuum) glass cylinder with electrodes at each end. Under the force of an electric charge the side of the cylinder can be seen to glow. If an element is placed between the two electrodes a shadow appears in the glow. The effect was made dramatically noticeable when Professor Braun, an Austrian physicist, used a mica screen coated with phosphorous. It was even more clearly seen when two more experimenters, Ryan and Wehnelt, at different times, improved the control and focusing of shadows and brightness.

A later variation was to use *rubidium* instead of selenium (because its response to light was faster), and a CRT as the transmitter as well as the receiver. It was many years later before all this came about however, and it was in 1923 that John Logie Baird made a spectacular breakthrough using the 'old-fashioned' scanning disc invented by Nipkow. In a small back room in Hastings, surrounded by bits and pieces

A cathode ray tube as used in a television camera.



of radio equipment, Baird experimented in broadcasting a picture of a ventriloquist's dummy over a short distance.

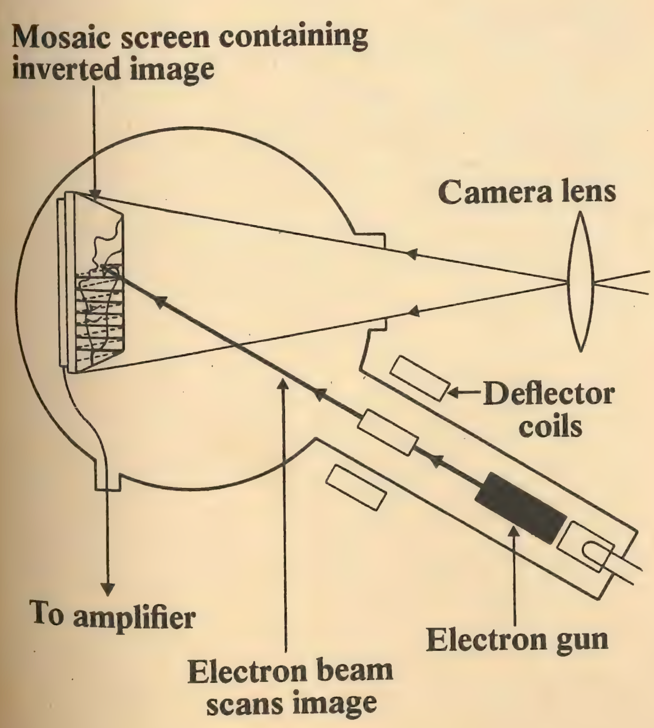
It was Baird, who, in 1926, transmitted by radio the first television pictures of the moving human face. He was the first man to broadcast television pictures for the BBC in 1929 and 1930, and in 1931 he broadcast pictures of the Derby horse race. His broadcasts were watched on 8″ × 10″ screens with thirty scanned lines per image – a breakthrough at the time, but crude when compared with the later 405 and 625 scanned lines per picture.

Baird's television transmission of the 1931 Derby.

What is an electron gun?

Before it was possible to achieve the sophistication of, for example, 405 lines 25 times every second, it was necessary to move away from the mechanical revolving disc invented by Nipkow and used by Baird. The final move came with the use of the CRT in both transmitter and receiver (by then commonly referred to as *camera* and *screen*).

A television camera with an electron gun.



It was as recently as 1934 that Marconi and his company appeared on the scene with a TV camera that used an *electron gun* instead of the revolving disc technique. Through its lens the new camera exposed the scene to be transmitted on to a screen of photoelectric cells. These cells became charged to varying degrees depending upon how much light fell upon them – namely, how much light there was in their portion of the scene. The charges were released when the screen was bombarded by a fine stream of electrons from the gun – a process again called *scanning*.

Between 1934 and 1936, there was much argument as to which of the systems would be best for public broadcasting, the Baird (with 240 lines at 25 images per second) or the Marconi (with 405 lines at 25 images per second).

Phosphor-coated screen

In February 1937, the Post-Master General announced the Marconi system was to be recommended for public use. However, it was not until after the 1939-1945 war that television was able to expand into the great force that it is today.

Now there is hardly a single section of society that is untouched by television and the present 'minor miracles' of technology such as transmissions across the Atlantic, from the Moon, and all in colour are almost commonplace. It is a far cry from Nipkow's disc, but improvements, novelties and inventions show no sign of easing off. As with radio, the future promises to be filled with surprises.

"Be not afear'd; the isle is full of noises,

Sounds and sweet airs, that give delight and hurt not."

How Television and Radio Work

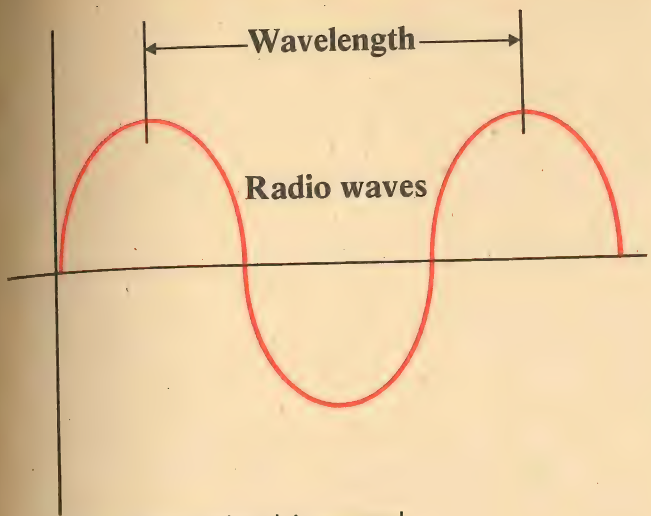
What is wavelength?

Light rays, sound, radio and television transmissions all appear to travel in wave formation, perhaps best imagined as a cross-section of the ripples formed when a stone is dropped in a pool. The *pattern* of wave movement in the water is very similar, only the speed is different. (Remember: radio waves travel at 186,000 miles per second.)

When a stone is dropped into a pond ripples are formed. They travel in a wave formation similar to that of light and sound rays.

If you throw a stone into the centre of a calm pond you will be able to see clearly the rings of ripples that will spread outwards from the point where the stone fell into the water. Transmitting aerials for radio and television similarly punch out rings of ripples except this time radio waves. When these rings of ripples pass a receiving aerial they induce sympathetic currents which are then converted in the receiver into Morse Code, speech, music and/or pictures. The receiver can be likened to a model boat on the pond bobbing up and down as the force of the waves works upon it.

When you tune in to your favourite radio station, you do so by choosing a specific *wavelength*. Radio waves operate through long, medium or short wavelengths. Wavelength can be measured from any point on a wave to a similar point on the next one, although the usual method of defining wavelength is from the perpendicular



How radio wavelength is measured.

lines drawn from the crest of one to the next.

What is an amplifier?

In the microphone, sound is turned into electricity through a sound sensitive ribbon or plate – a *diaphragm*.

In the television camera, pictures are turned into electricity through light sensitive cells which these days are made of *caesium*.

Both sound and vision electric impulses have to travel a long way to reach as many homes as possible. If they were left to themselves they would be too weak to be useful. They therefore need to be *amplified* (strengthened or boosted) when they are sent out during their journey and at the receiver. This is one of the jobs undertaken by valves and transistors. Weak signals are received, sometimes from thousands of miles away, boosted with more energy until they are sometimes ten million times stronger, and then passed on to receiving stations.

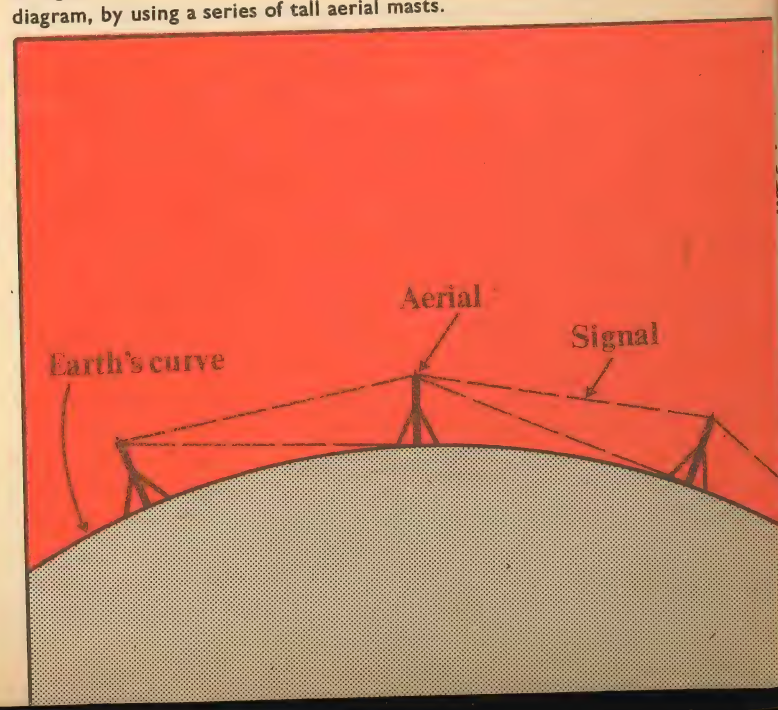
Why do we need aerials?

To transmit over oceans and deserts we need link stations with their connected aerials. The tall masts of aerials help overcome a major problem caused by the fact that electromagnetic waves travel in straight lines and the surface of the earth is curved. Many aerials and transmitters are used therefore to ensure good reception everywhere.

How do receivers work?

Receiving aerials at home collect both sound and picture signals from the air. Since the wavelengths for sound and vision transmissions are different they do not get confused, nor do they disturb one another. Receiving signals at home is almost the reverse of transmitting them. The impulse waves are collected, amplified and changed back from electricity into sounds and pictures. These are then put out in the way we all know through loudspeakers and screens.

The surface of the earth is curved, but radio waves travel in straight lines. This problem can be overcome, as shown in the diagram, by using a series of tall aerial masts.



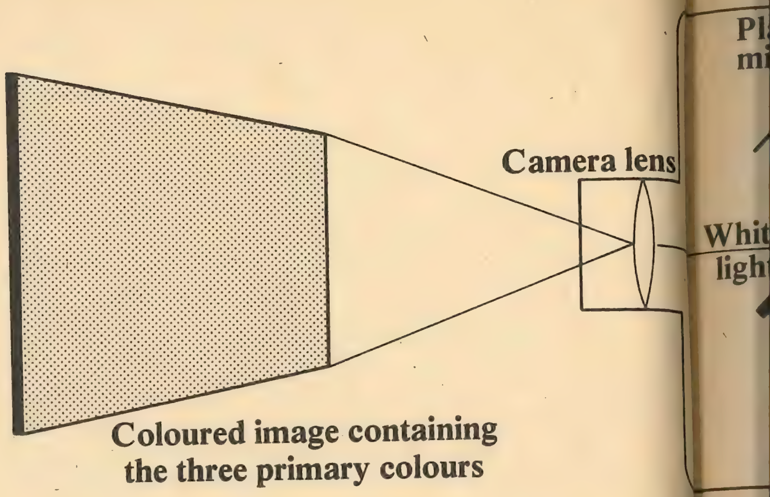
What is scanning?

The sounds from the speaker are a general blend and the single diaphragm in the ear accepts them as such and makes sense of them. The pictures from the screen have to be sent individually to the many cells in the retina of the eye so that the separate details are transmitted and re-assembled so quickly that the eye does not observe the building-up process but sees merely the finished product. This is why Nipkow's Disc and Weiller's mirror drum were used. Their method of operation was called *scanning*. That is how the electron gun inside today's television camera works. The first line of the picture is scanned and then taken out, then another and then another and so on. This is always done from left to right, until the whole picture has been made into lines that can be sent one after another. The electron gun inside the television camera sweeps the target screen with its needle-sharp beam. The charges made in the cells by this scanning build up long queues of impulses that are amplified and then transmitted at a rate of thirty every second: so fast that the eye cannot pick out any individual picture and therefore sees apparently continuous motion.

How does colour television work?

So far we have considered only the effects of variations of light *intensity* on television transmissions – not the complexities in the hues and tints of *colour* television.

Basically colour television pictures

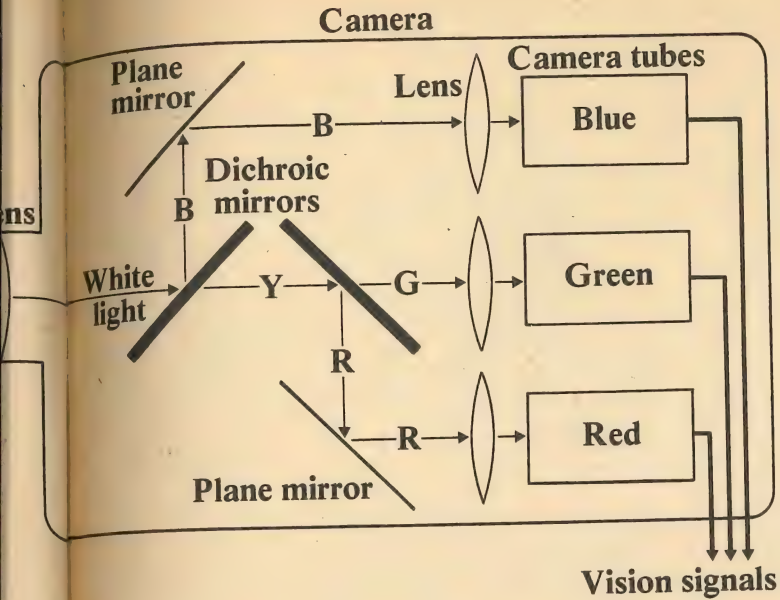


The dichroic mirror system in a colour television camera.

B=Blue G=Green R=Red Y=Yellow

are made in the same way as black and white, but to make full-colour pictures *three basic colours* are used: the three primary colours, red, blue and green light. These make up ordinary white light, and are always to be found in it. The wavelengths of these three colours are different (only slightly but definitely so) and this provides the key to colour transmission.

The light coming into the camera is split up into the three primaries by a set of *dichroic* mirrors. (Dichroic comes from a Greek word meaning *two colours*.) These mirrors are selective in which colour wavelengths they will reflect. Each colour is then led to its own electron gun and screen which send out their own signals (pale or intense) into one combined stream. A *de-coder* separates the colours in the receiving set and once again the colours are led to their own electron guns. In front of the guns is a fine mesh grid giving on to thousands of phosphorous spots, each grouped in threes – one red, one blue and one green. The guns are



positioned so that they can only activate their own colour and as they fire their electron impulses the screen comes alive in full colour, reflecting truly the hues and tints (pale or intense) of the original picture.

What is CCTV?

Black and white television pictures as well as those in colour are broadcast to many millions of people every day. There are many other television transmissions which never go 'on the air' as radio waves or to the viewing public at large. They operate with small low-power cameras, transmitters and receivers and send their signals through a network of cables. The sounds and pictures can only be picked up if a receiver is plugged in to the wired (closed) circuit of the transmission. Thus the system is called *Closed Circuit Television* (CCTV) as opposed to the open dispersal of signals through general broadcasting. Some of the many uses of CCTV are mentioned on pages 45 and 46.

What is stereophonic sound?

Colour brought to television the richness of natural pictures denied in black and white transmissions. Stereophonic equipment brought a similar richness into the world of broadcast sound. In everyday life we appreciate the vastness of our live world of sound (as well as distance and direction) because we have *two* listening posts: our two ears that work *independently*. If we are to hear radio signals that accurately reflect and reproduce these natural richnesses in sound, there must be two sets of microphones and speakers capable of sensing, transmitting and reproducing the many varieties of sound. This must be done almost as well as if we were present and hearing the source of the sound itself. Namely, the system must become our extended ears being capable of separating and blending the sounds we wish to hear.

Progress has been fast and furious in the past thirty years. Perhaps it will not be long before we are able to see television pictures in full three-dimension (3D): that is stereoscopically, as our two eyes enable us to do naturally.

A CCTV set-up in a department store.

A stereo sound broadcast transmitting from the music studio and being received at home on headphones and loudspeakers through a combined radio receiver and record player.

Studio Productions and Outside Broadcasts

Where does a broadcast begin?

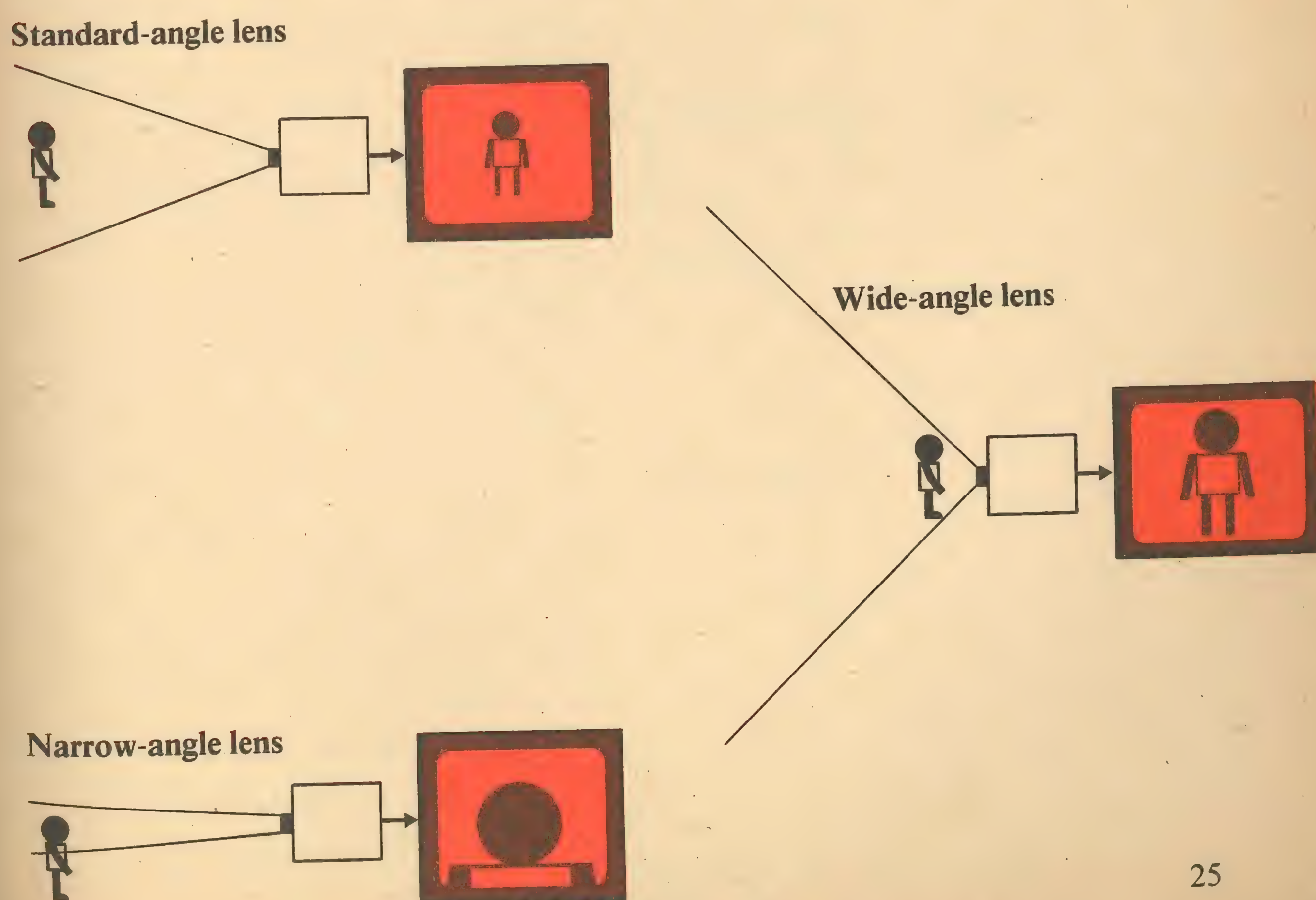
Before a programme goes 'on the air', whether for television or radio, live or recorded, many people will have been involved in special jobs and great use will have been made of expensive and sophisticated equipment. In the early days of broadcasting (television as well as radio) the transmission of news was the most important and dramatic event during all programmes. Now that we are used to radio and television the novelty of immediate news bulletins and flashes has worn off and the news has to compete on a more equal footing with many different kinds of programmes. Some of these various types will be mentioned in the next chapter. Here we shall look at the preparation, production and transmission of one kind of programme that calls upon

most of the resources of broadcasting and is typical of the best in radio and television styles: a play.

All programmes originate from just an idea. A play starts with a *script-writer*, and this title describes him well since he has to write down many more details in his play than the average playwright. He must provide the words that are to be said and describe any action that goes with them. He must also describe the setting in which the action takes place. An ordinary playwright can do this in an ordinary way, but there are special factors to be considered in plays for radio and television.

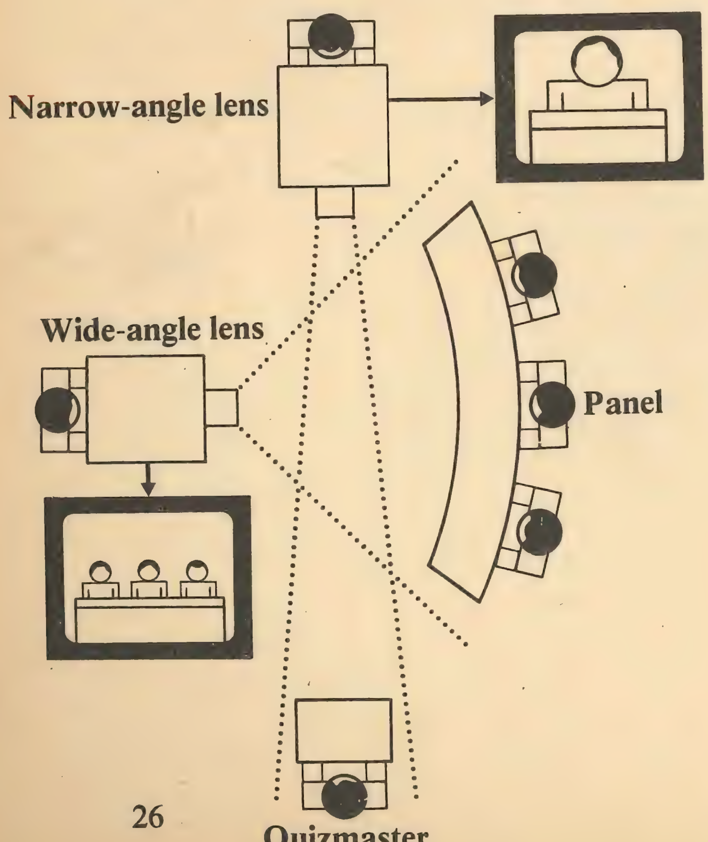
In a radio play all the action and the setting must be described in *sound effects*. If a scene takes place in a jungle, this must be conveyed by sounds which will convince listeners. It would be boring if the characters in the play were left to describe the jungle and what they were doing there. It is much more exciting, alive and real if the listener can hear for himself the cries of the birds and animals, the sounds of rushing water, falling trees and trampled undergrowth. Radio is much more than just television without the pictures. It is a complex weaving and blending of voices and sound effects to create a whole world of its own in which the listener feels at home, living and moving with the characters in the play, *identifying* in fact.

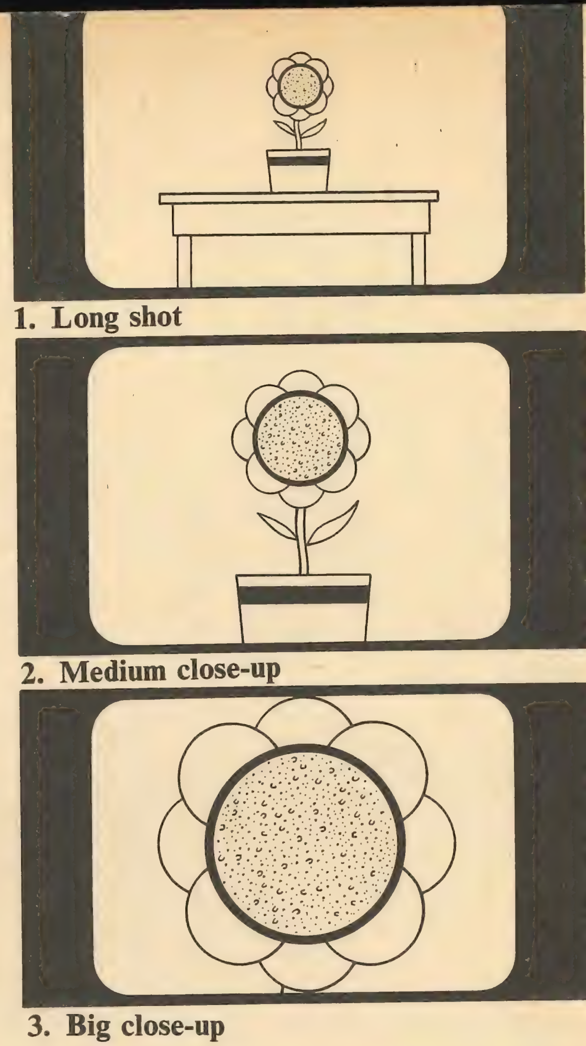
Three face-on views of the same subject using different lenses.



Sound effects also play a part in television plays but they are usually tied down to the action that the viewer can see. The special factor that the television scriptwriter must consider is precisely how he is going to *fill the screen* and how each picture is going to *move on* to the next. The filling of the screen is determined by the camera position (is it to be near or far away?) and the type of lens used. The variations here are tremendous. A wide-angle lens will include a great deal of any subject, even when used quite close whereas a narrow-angle will select details. By combining camera position and choice of lens, the picture can be varied from a wide shot of open country to a big close-up of a hand or even an eye. The way shots move from one to another must also be considered.

Narrow-angle and wide-angle lenses in use in a TV panel game.





A zoom lens allows the image to change uninterruptedly from a long shot to a big close-up.

There are three main methods. The straight *cut*, when one image is replaced immediately by another; the slow *fade-out* of one image followed by the fade-in of another; or the fade out of one at the same time as another is faded in, which is called the *dissolve*. A final factor, much in use today, is the *zoom lens* which allows the image to change uninterruptedly from long shot to close-up, slowly or quickly. Although many decisions about all these factors will be taken by the director during rehearsal, the scriptwriter has the initial responsibility of indicating what he feels should be done with his play.

Although the first idea may come from a scriptwriter, it stands no chance of being broadcast until it has been accepted, scheduled and a *producer* placed in charge. The producer is responsible for all the administration and finance of the show – including the hiring and firing of all staff, actors or technicians. He is totally in charge of the business side. One of his first jobs is always to appoint someone to be in total charge of the artistic side. This is the *director*.

What does a director do?

Taking part in the production of a radio play, there will be the cast in one large soundproofed studio and the technical crew in a separate, smaller room. The director (often confusingly referred to as the producer) can watch the actors through a large window. He can hear all that they say through headphones ('cans') or loudspeakers and can talk to them through his own private microphone. It is his job to draw together the speeches and sound effects into one convincing whole and help the cast with their interpretations of their parts: happy or sad?; loud or soft?; how long a pause? etc. He controls the levels of sound from the many live microphones and effects inputs. All the technical assistants work under his direction – starting and stopping their effects when he indicates. One of his most important pieces of equipment is his stop watch!

A television director performs all the tasks of a radio director and many more. Since his presentations will be seen as well as heard, there are two additional features to be considered: what the actors and the settings will look like; and what each of the many cameras will be showing. Obviously a camera placed in front of an actor will give a very different shot from one placed behind him. Viewers may need to be shown his face or his hands behind his back and only one camera can be right at any one time.

A television director is responsible for the final outcome of the complete programme. He has many specialists to help him but the final responsibility is entirely his and it is something of a challenge.

He is in complete charge of the studio *Control Room*. His right hand man is frequently a woman (a 'Girl Friday') – the *Production Assistant*. Her script contains all the cues, timings and notes, for she has to be the director's eyes, ears and memory. Nearby will be the skilled technical assistants: the *vision mixer* ready to cut, fade or mix as the director instructs (this is done through an electronic board); the *music and sound* crew ready to feed in their naturalistic effects and/or atmospheric music at the right volume at the right time; the *electrician* who operates the lighting console – a complicated electronic keyboard that controls and adjusts all the lighting in the studio; and the *telecine operator* ready with filmed titles, graphics and other inserts – all carefully timed to run exactly as the director wishes.

Who helps the director?

All this electronic wizardry represents the culmination of weeks (and often months) of preparation. The director (often with help from the producer) will have cast the production (having auditioned many actors and actresses), conducted at least one read-through, and many rehearsals from rough ones with working moves (*blocking in*) to more detailed sessions just before everyone moves into the studio. All these rehearsals will have been without lights, cameras, etc., and are referred to as *dry runs*.

During this period of rehearsals the director will have been discussing and planning the appropriate details with the designer, the lighting and camera chiefs and the floor manager. It is the *floor manager* who will actually run the studio when they move in and he is the link between the director and all those working on the floor. He is responsible

A make-up girl at work.

A television play in rehearsal.

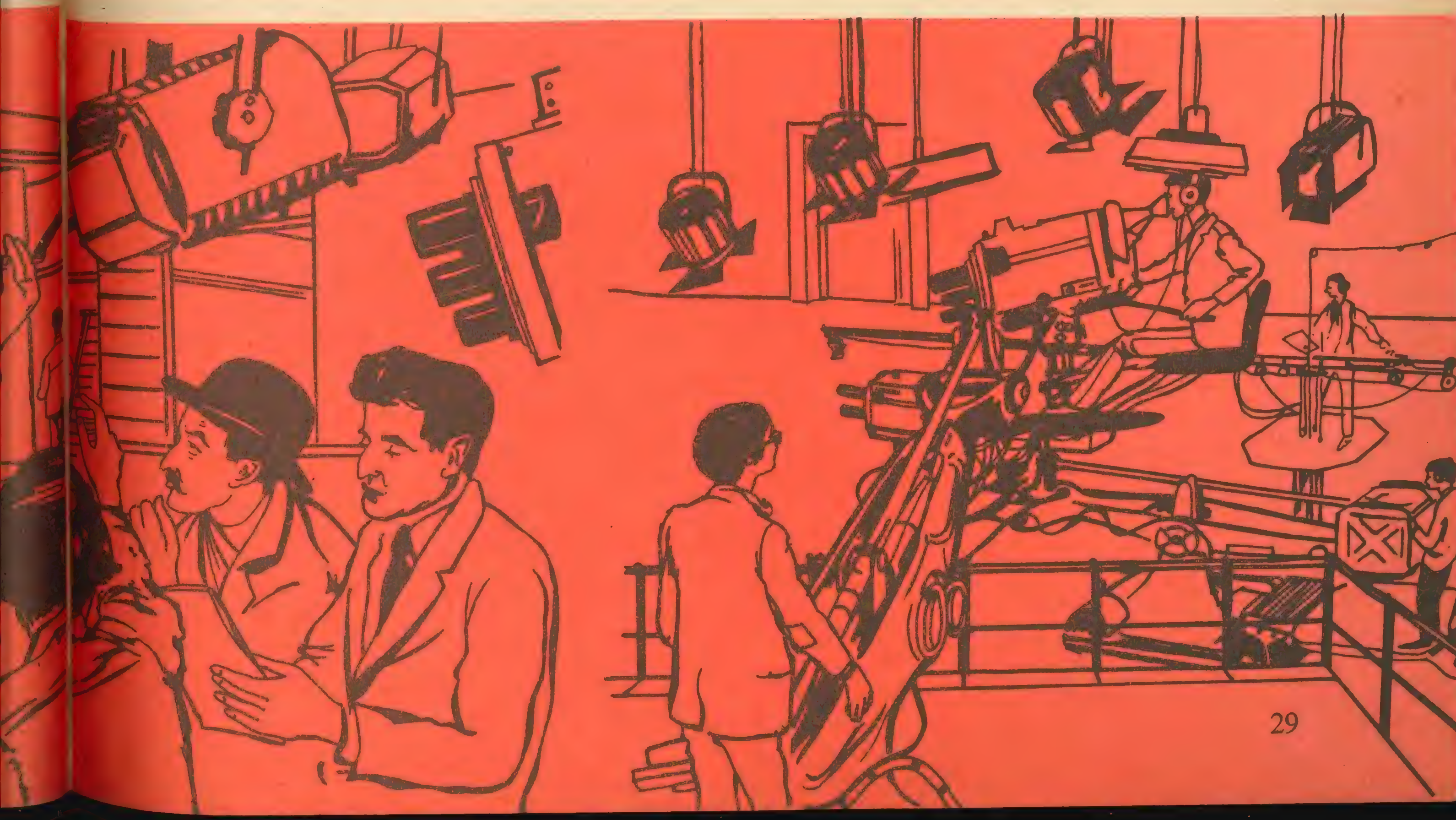
for ensuring the director's instructions are carried out whether it is a change in make-up disapproved of by a temperamental leading lady, the return to rehearsal after a coffee break, or the provision of a small property like a match-box. He may have an assistant called a *stage manager*.

At this time the cast will have their first experience of the set, costumes, cameras and lights. The designers will be there, backed up by painters, scene hands, property men (they look after all the things the actors actually handle in the production), and there may even be plasterers and carpenters on call. There will also be a host of others: wardrobe mistresses, dressers, make-up girls and hairdressers. There will also be the *continuity girl*. She is there to ensure that no detail is overlooked when the action returns to a scene. The clock must tell the right time, the candle have burned down the right amount, the girl-friend be wearing the same flower, etc.

Most important and essential to television, there will be the eyes and ears of it all: the cameras and microphones. These are mainly in plain view to the cast and studio staff but not intended for home consumption.

The *camera operator* receives the director's instructions over his headphones. There may be four or five cameras allocated to a production and they each have their own team of pushers, pullers and sliders whose job it is to move the camera (which may be on a small platform or dolly, or huge crane) as the cameraman tells them by means of his special silent code of gestures. *Microphone operators* work in a similar way 'fishing' for sound and always trying to keep their mike (and its boom) out of camera.

Camera and microphone operators on the studio floor.



A television Outside Broadcast crew at work.

The picture from each camera and the sound from each microphone are fed into a *technical control room* where they are checked for technical quality and balanced against one another. They are then fed into the director's control room where they form the ingredients he mixes to create and send out the programme composed of one set of sounds and images at a time.

Why are studios needed?

Some years ago, most plays, whether in a theatre, on film or television, had very few settings. Nowadays the action roves, moves and jumps quickly from one setting (the *location*) to another. If such action is to be televised without a break, the sets must be positioned closely together. It is quite obviously out of the question always to use real locations because of the prohibitive amount of time, travel and money involved. This means that rehearsal and shooting spaces must have plenty of room. Such places are not easy to come by and even when they have been found they seldom have the facilities needed by radio and television, especially the complete control over sound and light (and even more especially over silence and black out!). The answer was, as with films, to build special studios.

Television studios look like elaborate electronically controlled film sets. By comparison – but by comparison only – radio studios seem to be sparsely equipped. Since many sets have to be built, workshops are usually nearby and both workshops and studios need plenty of space to handle the many sets in use during any one presentation, never mind the numbers handled during one week. Radio has a distinct advantage over television in the matter of space, since most of its effects are achieved by suggestion and not realistic use. This was to be noted to great advantage in *Under Milk Wood* (by Dylan Thomas) in which the action

ranged from this world to the next while supposedly being contained in a small Welsh village. Orson Welles achieved a tremendous impact with his dramatisation of Wells' *War of the Worlds* over New York radio. (So many citizens thought it was a real invasion that the highways were jammed.) Thomas' piece was a bombshell and, to the BBC's credit, it was specially commissioned. Television has yet to discover its parallel break through production.

How important are tape and film?

Not all radio or television presentations come from studios. Programmes which take place away from the studios (sport, news, open-air features, etc.) are covered by on-the-spot *Outside Broadcast* crews. They work with mobile miniature control rooms and frequently go on the air live, through a land-line or portable transmitter, which they rig up themselves and so remain in touch with the main studios and transmitters.

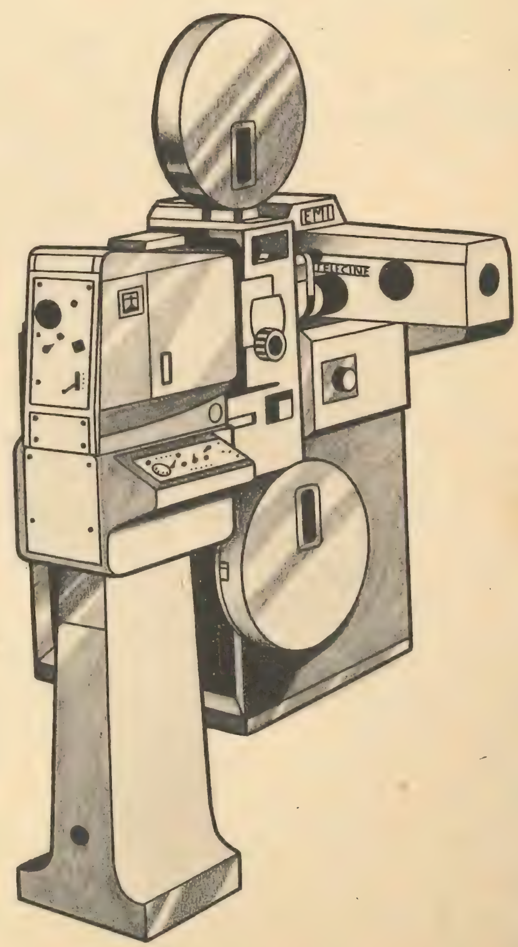
Outside Broadcasts (OB's) are not always transmitted live and much material comes into the central studios on tape (for both radio and television) and on film (television only). The material may be used straight away (if of immediate interest, like 'hot' news) or stored for later production.

The tape used for storing radio programmes is like that used in domestic tape-recorders: $\frac{1}{4}$ inch wide magnetic tape. That for television is 2 inches wide and records sound and vision on two separate tracks on the one width of tape.

Film used for television is the same as that in the cinema. The film size (gauge) varies from 8mm to 16mm to 35mm. A special *telecine* projector converts the cine film images into electric impulses for transmission.

The organisation, production and direction of a presentation employs many people, talents and equipment, and draws on many resources from industry, commerce, advertising and the arts. The selection of programmes to be shown, however, is not in the hands of these people but in those of the programme planners.

A telecine projector.



The Programmes and the Planners

What were the most historic moments in broadcasting?

On July 19th, 1969, Neil Armstrong walked on the surface of the moon. Almost to the very micro-second, a quarter of a million miles away on earth, nearly 750 million people watched him do so. The world's population was, for a short time, almost a single community, as more than one person in five from nearly fifty countries watched and listened together. This mass viewing, in its way a comparable achievement to travelling to the moon, took place only fifty years after the first faltering, public radio broadcast in Britain.

That, too, was an historic moment. In 1919, the Marconi Company was granted a licence to broadcast experimental transmissions of speech and music from Chelmsford. In June 1920, jointly promoted by Marconi and the *Daily Mail*, there was the first public broadcast of a general entertainment nature: a concert by the well known singer Dame Nellie Melba. She was heard not only all over Europe but as far away as Newfoundland. In 1922, a radio station opened at the top of Marconi House in London's Strand. Its code name, 2LO, was to go down in history. The first broadcasts were supposed to be no more than demonstrations and not publicly advertised, but the listening population grew and at last radio had arrived.

The first public broadcast that was purely entertainment, was a concert given by the famous singer, Dame Nellie Melba.

Neil Armstrong walking on the moon. People could watch this momentous event on their own television screens at home.

H&W–R&TV–C

Looking ahead, the GPO invited applications from companies to run a national service and even went so far as to suggest they should get together to form a single British Broadcasting Company. This they did and on November 14th, 1922, the BBC took over 2LO. Within days, stations were opened in Birmingham and Manchester and within weeks a national service was broadcasting for 4–5 hours daily. This was followed by perhaps the most important single job appointment in radio, when John Reith, a Scots engineer who knew nothing about broadcasting, became the BBC's first General Manager. He stayed with the BBC, putting his stamp of high moral tone on it and defending its independence, as its chief executive until he resigned in 1938. By then the BBC led the world in radio broadcasting, and its style and technical expertise made their mark on almost every other broadcasting system.

Who started the BBC?

Radio rapidly grew in popularity. By March 1923, the GPO had issued 80,000 licences to operate radio receivers. By September 1924 the number had reached nearly a million. It seems likely that the actual number of listeners was nearer five times that figure. By September 1925, 40 million people were within range of what the BBC called "uninterrupted service" and by 1928 the BBC was producing over 60,000 hours of radio programmes to audiences never below one million and frequently in excess of 15 million.

No sooner was radio established than television crept on to the scene. The BBC began the world's first technically satisfactory service in 1936. By 1939 it had presented, to approximately 20,000 viewers, a Coronation, Wimbledon, Derby, Test Cricket, a Cup Final, an Oxford-Cambridge Boat Race, and more than three hundred plays. The 1939-45 war closed down television until 1946. The first programme after the war was celebratory of victory and was watched by more than 100,000 viewers. It grew only slowly until the coronation of Queen Elizabeth II in 1953. The TV coverage was a complete success watched by more than twenty million people in Britain and overnight the demand for television sets rose by fifty per cent. By this time TV licences had been issued to over 1½ million homes. (Radio licences reached a peak in 1950 at nearly 12 million.) Ever since then BBC television has developed rapidly and this is clearly reflected in the money spent on programmes. In 1953, the figure was just under £4 million and by 1971 it had risen to nearly £70 million.

Shortly after its successful coronation transmission the BBC had to cope with competition for the first time. 1955 saw the arrival of commercial television, and the BBC took a nasty fall from a monopoly position. It was not long before it had less than a third of the viewing audience. Advertising revenue on the commercial channels rose from £2 million in 1955 to £64 million in 1960! But supported by its history and its stubborn independence the BBC soldiered on, retaining its standards and regaining some of its lost viewers. It was rewarded by the Television Act

of 1964, which criticised the commercial companies for not living up to their responsibilities, and by the granting of its second channel – BBC2.

What is the IBA?

The BBC's top job is that of Director General but it does not allow the holder a completely free hand. The BBC is presided over by a Chairman and eleven governors, who may or may not have experience and expertise in broadcasting. The BBC's authority is vested in a Royal Charter, and this requires that the BBC shall broadcast "information, education and entertainment".

The commercial television companies are controlled by an Act of Parliament which uses the same words as the Royal Charter and goes on to say that "a proper balance and wide range in subject matter" must be given and there must be "wide showing for programmes of merit". This of course leaves much to discretion and imagination.

Programme planning, co-ordination and approval are self-contained within the BBC but for commercial television the matter is not so simple. There are five network groups (major companies broadcasting to the whole country): Thames, London Weekend, ATV, Granada and Yorkshire. There are also ten regional companies as well as

A designer in conference with a director.

A radio programme in rehearsal.

A television play in rehearsal.

Independent Television News which is owned and used by all the companies.

With so many companies competing for the best viewing times there is a lot of hard bargaining always going on. This takes place in committees representing all the companies: the Network Programme Committee and the Programme Controllers' Group. Supervising the whole operation of commercial television is the Independent Broadcasting Authority (IBA). It used to be called the Independent Television Authority (ITA) but with the introduction of local radio in the 1970's by both the BBC and commercial groups, the Authority's terms of reference were broadened to include that development. (However, it still has no effective authority over the so-called 'pirate' stations like Radio Caroline.) The IBA owns and operates the transmitters and links of the whole commercial network. It also draws up and makes contracts with the individual companies and has the legal right of veto over any programme and can withdraw contracts if it feels a company is not doing its job properly. It supervises the schedules of programmes to ensure a proper balance and expects at least a third of all programmes to be 'serious'. It also vets specific programmes for style and content – keeping a special eye for 'sex and violence'. It is equally watchful of advertising, ensuring that no more than the allocated time is given during any hour or any 24-hour period. 'Commercials' are also controlled by the IBA's Code of Advertising Standards, which sets out to prevent misleading information being given to viewers.

Who pays for the programmes?

The IBA is similar to the BBC in that it has authority members presided over by a Chairman, and is controlled by official regulations. There is, however, a major difference. The BBC is financed by the income from licensing while the commercial companies must gain their income from selling advertising time. In 1970, the BBC received nearly £100 million from licensing, about three-quarters of which went to television. While the commercial television companies may have a similar income they have to work hard to get it by employing large full-time Sales Departments. Not only do they sell advertising time to businessmen, they also collect information about audience numbers, likes and dislikes. Calculating businessmen want value for their money and this means getting through to the largest number of viewers at the smallest cost. The fees that pay for advertising time are recouped from the retail price of goods and therefore in a round about way we pay for our television programmes twice, once with a licence and again with every packet of soapflakes or whatever else we may buy.

Do we get the programmes we want?

The ordinary viewer may pay directly or indirectly for his programmes, but he has no immediate control over the transmissions. His only effective expression of dislike is the ON-OFF switch.

Over the years, television companies have come to understand something

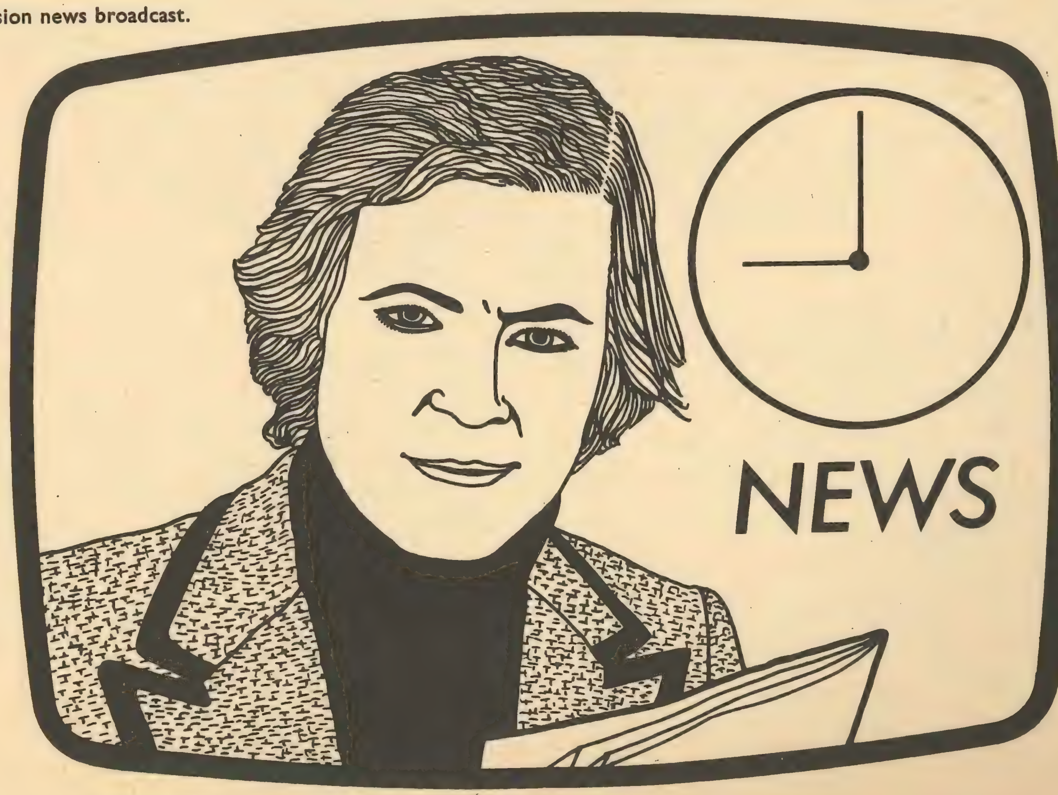
of the nature of popular demand for certain programmes and also the need to meet minority wishes. Programmes can be fairly clearly divided into sections: news, drama, information, light entertainment, sport and films.

We have already seen something of a drama department in action and, in Britain alone, television presents an average of one full length play a day. But this is only part of the picture. Drama departments are also responsible for short plays, series and serials. These range from domestic tear-jerkers to detective thrillers and from dramatisations of little-known novels to classic fairy tales.

Similar pressures work on the news departments, both national and regional, presented straight or in magazine form. British television news is the envy of the world for its impartiality and freedom from interference by politicians, press or commerce. The BBC and ITN vie with each other to present the news attractively, efficiently and fast and although the commercial programmes tend, as they do generally, to more informality than the BBC, there is now little to choose between the two.

Britain gave the world a lead in documentaries with John Grierson's films and the BBC's radio 'feature' broadcasts. Radio skills were transferred to television (especially from the Ideas and Research departments) and it was a long time before ITV caught up with the BBC. Documentaries offer rich opportunities in presentation and a whole new sense of styles has been opened up to show people to people – living, loving, laughing, dying, working and playing the world over.

A television news broadcast.



A television 'chat' programme—notice the unobtrusive microphones.

The commentator, interviewer or the 'anchor' man is important in many documentaries. Very popular now are the probing face to face interviews with a public figure in the 'hot seat' and the camera in close-up. So are the many 'chat' programmes: small groups in a studio; specialists linked from country to country; panels; and edited film encounters. A difficult task for any interviewer is to press the interviewee hard enough to get an interesting and lively response yet not so hard that the atmosphere becomes destructive. Many interviewers have been tempted into abusing the power their job gives them and at least one public figure has been brought to real tears as a result of a punishing interview.

A very large proportion of every week's viewing is given over to films, sport and light entertainment. This last section has many sides covering the long-running comedy series to the spectacular musicals or from the many panel games to the audience-participation shows with their tempting prizes. Surprisingly, ballet, opera and music have not been well-served on television (except perhaps for pop music). The field is still wide open for a talented innovator to discover exciting new forms for the television presentation of light entertainment.

In an operating theatre full of people and equipment, students are able to watch the details of an operation on Closed Circuit Television.

The police and traffic controllers can watch motorways on CCTV.

CCTV in use in a school.

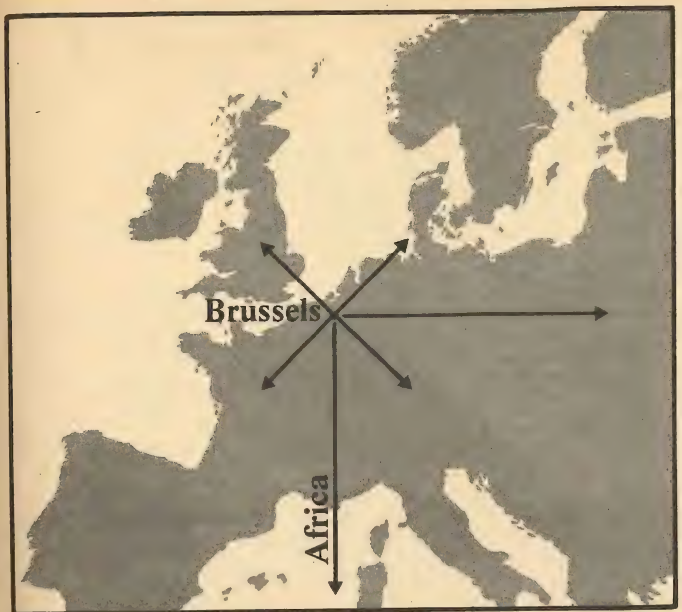
Those who live to please must please to live and every one concerned with mass media entertainment needs to know the impact and popularity of what they put out, especially the advertisers. The BBC employs its own audience researchers. Two other well-known organisations are JICTAR and TAM. Methods vary from personal interviews to viewing diaries, to meters fitted to home sets, but they all have the same aim which is to find out directly from the viewers what their critical opinions are. Another method is to read the TV critics in the newspapers, but much as the press is respected for its 'quality' reviews and prizes, it is seldom relied on to indicate whether a programme worked on the viewers generally. In fact, the better reviews a programme gets from the professional critics, the more likely it is to rate a low mark in popularity.

What do the critics do?

Commercial success and overall popularity are at their extreme in the United States of America where over 60 million homes have television sets, nearly half with colour and more than a third with at least two sets. Only sleeping uses more time than television watching in the USA. One manufacturing company annually spends more on sponsoring television programmes than the BBC receives from licences. (Sponsoring is the US equivalent of British advertising where advertisers buy time and actually provide the programmes.) The total

How popular is television overseas?

Drawings for a television commercial.



The area covered by the European Broadcasting Union.

revenue of US television approaches £2,000 million and with such a figure it is almost impossible for producers and directors to get away from its influence.

Canada patterned its first system on the BBC and, after a time, permitted commercial channels to compete as they do in Britain. Australia settled for a slightly different system whereby there are state-owned and private enterprise channels operating in direct competition. The commercial companies own their stations (similar to Britain) but advertisers are allowed to sponsor parts of programmes (different from Britain).

Africa and South America have problems of distance and language, not to mention political changes, but television is slowly achieving a position of importance, especially in education. In Russia, television and radio are both used to further social, educational, cultural and political ends and to boost pride in Soviet achievement.

Although interest in television varies greatly throughout Western Europe (with Germany and Britain being very TV conscious and the Latin countries less so) the link known as Eurovision provides a remarkable service. Brussels is the centre for a television network that links up, at least twice a day, thirty television stations in more than twenty countries in the European Broadcasting Union. The network is also linked to Africa and Intervision, its counterpart in Eastern Europe and Russia. Programmes from Brussels can be immediately relayed to the 100 million home television sets in Western Europe – a truly remarkable feat.

How Radio and Television Help Us Work, Live, Learn and Play

Who uses Short Wave radio?

Sir William Preece helped the progress of broadcasting by his work at the Post Office and his encouragement of Marconi. When he died in 1913 he had seen the whole world linked by radio and not only the long wave broadcasts of national companies.

A •–	M ––	Y –•––
B –•••	N –•	Z ––••
C –•–•	O –––	1 •––––
D –••	P •––•	2 ••–––
E •	Q ––•–	3 •••––
F ••–•	R •–•	4 ••••–
G ––•	S •••	5 •••••
H ••••	T –	6 –••••
I ••	U ••–	7 ––•••
J •–––	V •••–	8 –––••
K –•–	W •––	9 ––––•
L •–••	X –••–	0 –––––

The Morse Code.

The ss *Volturno* burst into flames in the middle of an Atlantic storm. The radio officer continued to send out distress signals in Morse (then CQD) and this was responsible for saving the lives of more than five hundred passengers and crew. The *Titanic* was also helped as a result of the bravery of its radio officer who went down with the ship, still sending the old distress code signal and the newly agreed one: *SOS*.

The *Titanic* in distress in the Atlantic. The ship's radio operator was able to send out a call for help.

One of the first police arrests to be helped by radio was that of Dr. Crippen, the notorious murderer. He was sailing to safety in the liner *Montrose*, bound for Canada, and would have escaped justice except for the ship's radio link with Scotland Yard.

The police, fire and ambulance services regularly use short wave radio to tackle crime, save lives and property and ease traffic jams. They are not the only users. Many people all over the world have found a hobby in short wave radio. These amateur enthusiasts are called *hams* and they have often been of great social service in times of distress: earthquakes, floods, large fires and the like. Their home-made kits have frequently helped rescues and saved many lives.

An amateur enthusiast transmitting from home.

What is CCTV used for?

Television has also developed a second string to its bow. Just as short wave broadcasting plays a small but significant part in radio, so does Closed Circuit transmission in television. Closed Circuit Television (CCTV) can be seen by comparatively few people at any one time since it sends its signals through a limited wire network, but one camera can be the eyes for a group of 5, 50 or 500 people, hardly any of whom (and sometimes none at all) would be able to get to see without it. CCTV helps us in many ways: observing the inside workings of a machine where a man cannot go; the traffic movements at busy crossroads; aircraft scattered on airfields; a surgeon operating in the small theatre space of a teaching hospital; empty factories where there might be intruders; and many other places where lots of people need to see but few can approach the scene under actual life conditions.

Schools and colleges are frequently *hooked up* (linked into the CCTV broadcasting circuit) for special teaching sessions where, perhaps, a celebrity lectures to a small group in a small hall. Students in halls nearby and also those some miles away are enabled to share the experience as it occurs. Universities

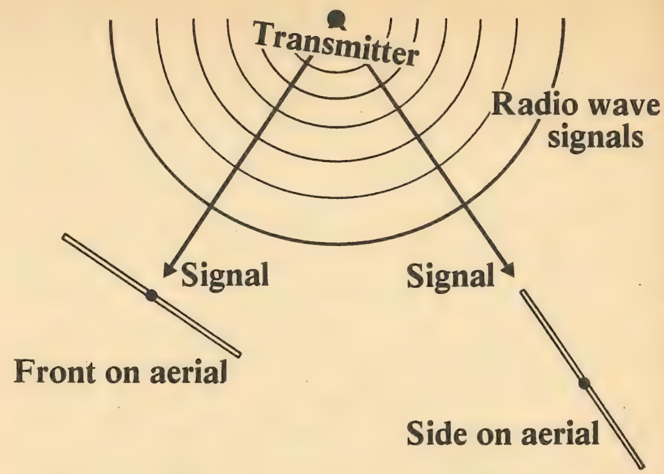
and factories are able to keep a whole campus informed of local news and developments as they occur through the daily broadcasting of news bulletins written and broadcast by the students or workers themselves.

Used in conjunction with video tape-recorders (machines which record and replay pictures and sound on magnetic tape), CCTV provides a flexible service that helps us to overcome the problems of groups of people not being able to observe a particular event because they happen to be in the wrong place or only able to attend at the wrong times. Space, place and time can now be re-arranged as a result of the techniques of Closed Circuit Television and its associated facilities. The future promises all kinds of developments in the way of linked connections in all kinds of neighbourhoods: two-way sound and video communication between homes, churches, supermarkets, libraries, banks and theatres, not to mention the no longer remote possibility of video telephone. Many banks already conduct much of their business with customers through CCTV sets to cut down the risk of bank raids!

What is Radar?

Not only have we progressed in person-to-person communication through the use of radio waves, but we have also learned how to use them in many scientific and technical ways.

As long ago as 1914 it was discovered that if an aerial is wound on a square frame the reception of radio wave signals is very different when the frame is *square* (front on) to the waves from



The angle of the aerial affects the quality of reception.

when it is *in line* (side on). The effect can easily be noticed by turning a portable radio set through 180°. As the set is turned the strength of the signal varies considerably, with the maximum strength signal being received when the aerial is in line with the radio waves. This *directional property* has been much used to help ships and aeroplanes get their bearings from the known positions of broadcasting stations. The system is called *Direction Finding* and shortened to *D/F*.

Another property that has aided navigation has been the reflective nature of radio waves. They bounce back in just the same way as sound and light and what they strike becomes a *radio wave mirror*. This was used in 1939 as the basis of the first Radar sets (RADAR means RAdio Detection And Ranging).

What do we get from satellites?

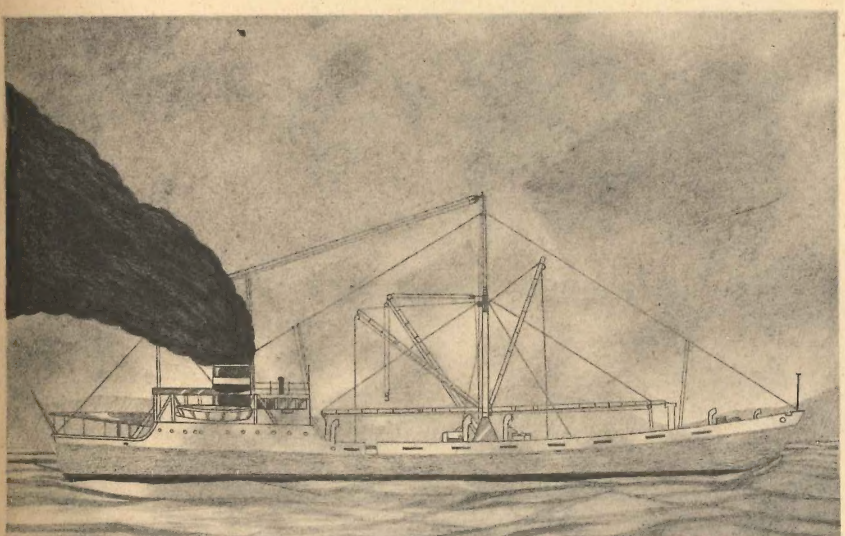
Radio and television are used in many ways, as we have seen. Ships use Radar in fog, and planes use D/F all the time. Weather reports, warning and time signals, news and forecasts for shipping, special

reports (including medical and other advice for shipwrecked sailors) are all passed on by radio. Police officers and many others use small 'walkie-talkie' radios in their work. Police cars (as well as many taxis) are fitted with two-way radios so that they can transmit as well as receive. Planes, ships, rockets and satellites (not to mention model boats, planes and tanks) can be guided by radio and the remarkable telescope at Jodrell Bank works by radio. Video and sound programmes are relayed by satellites to link up continents across oceans and deserts. Satellites are also equipped with TV cameras to help us observe our world, its weather, its vegetation, its oceans and its crops. All this is done from outer space.

We can now communicate in sound and vision from one end of the earth to another which is a great leap from Hertz's first small jump across a spark gap.

And the story is by no means finished. It is still going on day by day. . . .

In foggy weather, Radar is relied upon for navigation and the prevention of collisions.



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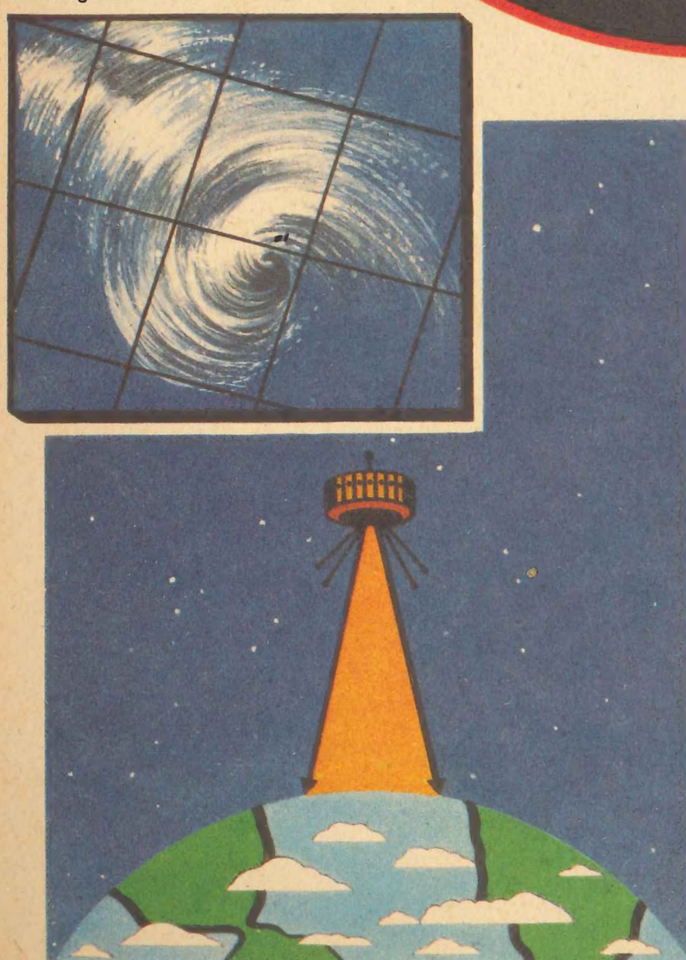
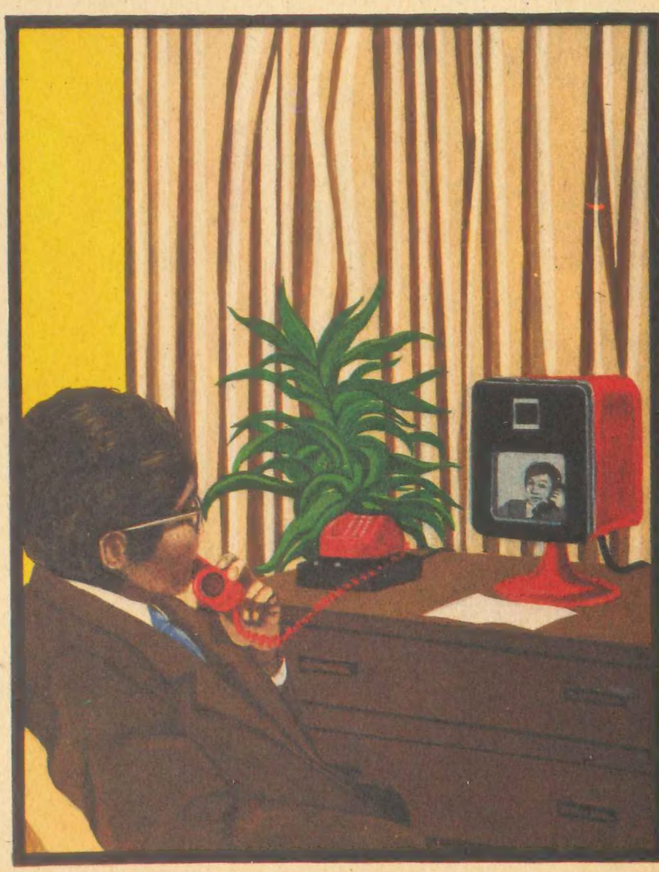
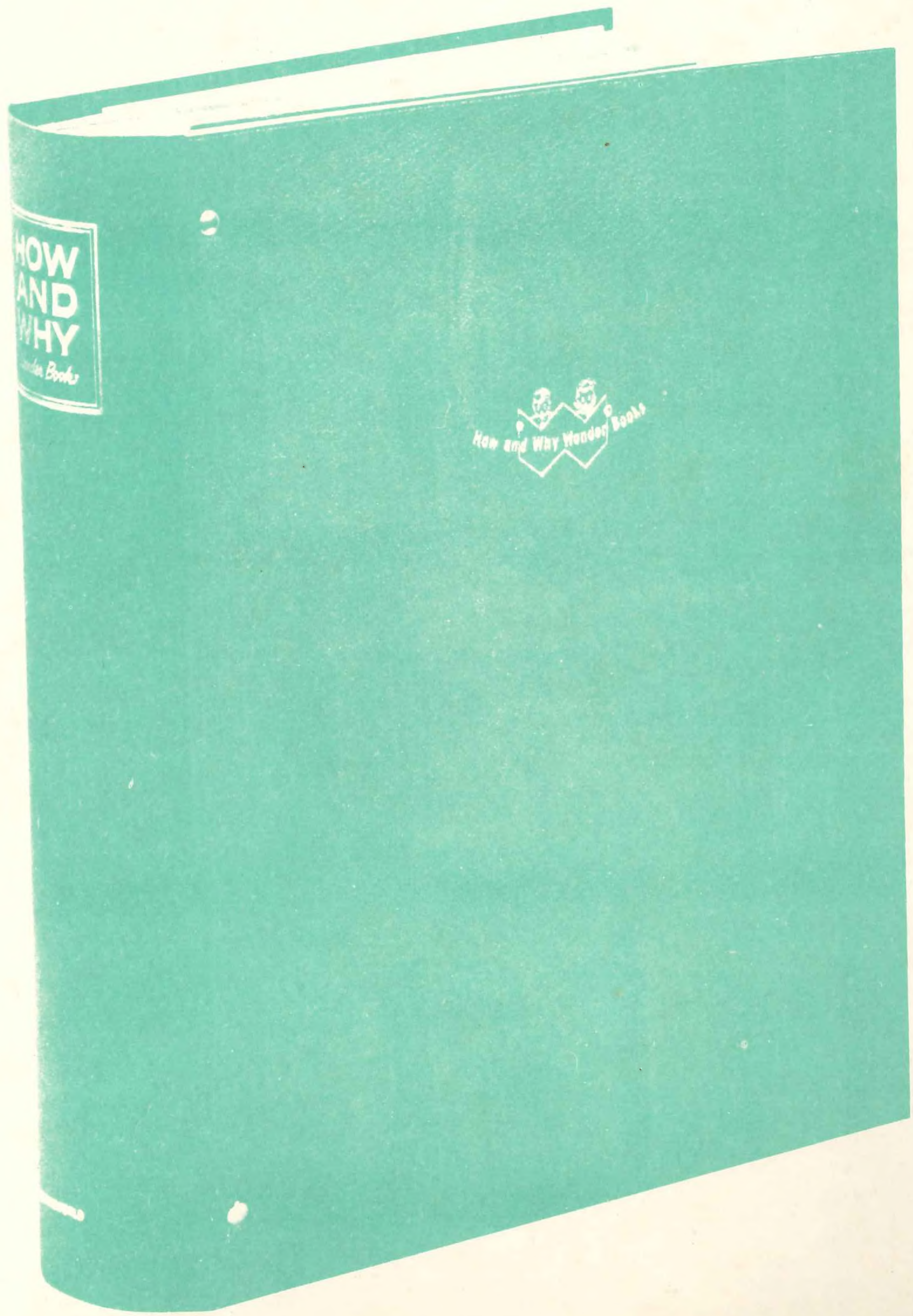
Jodrell Bank Radio Telescope.

Weather satellites viewing and tracking a hurricane.



Video telephones in use.

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